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CLASSIFICATION OF INFLAMMATIONS OF THE THROAT

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CAMPINAS, SÃO PAULO, BRAZIL

THE CLASSIFICATION of the different involvements and diseases of the throat is a problem which has defied and tried the skill and the didactic ability of laryngologists. The difficulty is due to several factors: first, to the existing confusion of terminology, which, in turn, is due to the fact that the throat does not represent anatomically or physiologically one single organ but a space made up of somewhat independent elements in which the upper digestive and respiratory systems are related; second, to the restricted orientation of those who have undertaken the task of dividing the conditions encountered in this region into classes. The two factors just given are, from my point of view, the greatest obstacles which one has to overcome in trying to distribute methodically and didactically the various pathologic conditions of the throat.

CRITERIA

The criterion to be followed when separating the pathologic processes located in the throat into classes must necessarily be the eclectic. Several isolated classifications may be admitted: (1) the course; (2) the cause; (3) the macroscopic, that is, the morphologic aspect; (4) the histopathologic alterations, and (5) the clinical evolution.

The course allows one to divide the processes only into two large groups: (1) acute and (2) chronic. This classification, despite its defects, must be maintained, as it really is throughout pathology. There are several defects. There are acute processes which soon develop into chronic, although typically acute, as for example abscess of the tonsil. On the other hand, chronic diseases may be manifested in acute phases as happens in the case of chronic cryptic tonsillitis. There are, furthermore, superacute and subacute involvements. Even so one cannot overrule this division.

The causes in themselves do not permit the physician to separate the diseases of the throat. Vincent's angina, for example, has a recognized cause; it is due to the association of one of the Spirochaetae of the mouth, which has not yet been precisely determined, and Bacillus

fusiformis[1] of Le Dantec. This angina, however, may be just a complication of a subjacent epithelial process. The real disease (i. e., the primary disease) could be, for example, an ulcerated epithelioma on which the angina had developed. The fusospirochetal process may also be due to a general condition of the body, as happens, for example, in leukemia and in granulocytopenia, in which there is, in fact, the typical Plaut-Vincent angina simply as a complication of the hematic process.

Furthermore, there may be a streptococcic infection of the throat. It may manifest itself (1) as erythematocatarrhal angina, (2) simply as a pultaceous tonsillitis, (3) as fibrinopurulent angina, (4) as phlegmonous angina or (5) as cryptic chronic focal tonsillitis. Therefore, a purely etiologic classification is not admissible.

The macroscopic or morphologic aspects allow one to recognize a series of types of involvements: erythematous, pultaceous, vesicular, phlegmonous, and others. It is evident, however, that a purely morphologic division cannot be complete. There are several forms that are alike in aspect but different in causation and in histopathologic appearance. One has an outstanding example in the hypertrophic-hyperplastic forms which may be simple hypertrophies or hyperplasias of different origins: hemopathic, syphilitic, tuberculous, neoplastic.

The histopathologic alterations are not sufficient to establish any classification, and this is proved by the insufficiency of Kuttner's classification, as will be seen from my comments on it farther on.

One finally comes to the clinical. One should understand from this term the conjunction of all the elements just cited, and when I spoke of eclectic classification I meant clinical. For the clinic takes into consideration all that has been cited: the course, the cause, the pathologic anatomy, the histopathologic alterations and even the therapeutics. I do not consider reasonable Escat's criterion in giving the subtitle of anatomoclinical to his classification. Can there be a clinic without anatomy, especially pathologic anatomy, which is what he refers to? The same can be said of Cambrelin, who labeled his division "clinical, nosological and morphological." How can it be possible to have a clinic without nosology if the latter is the ground of the former?

There is, therefore, only one criterion to be adopted in classifying the ailments of the throat: It is the eclectic, based on the evolution, the etiologic factors, the morphologic aspects and the histopathologic observations.

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1. Sanarelli, after careful microbiologic studies, including artificial cultures, arrived at the conclusion that the spirochete and the bacillus are but different forms of the same micro-organism, which he named Heliconema vincenti. While such studies are not universally recognized, one must continue to accept the idea of the fusospirochetal symbiosis.

It is useless, even so, to insist on the difficulty of establishing the classification. This is proved by the fact that in handbooks covering this field there are not two classifications alike and that the writers of many of them do not even attempt to make a division.

It should not be assumed, however, that to classify the diseases of the throat as those of any other region is destitute of importance or even that it is of secondary importance. The truth is that without this kind of orientation it is much more difficult to teach the subject; without order, method or systematization it becomes not only arid but also obscure and unprecise. The classification is, therefore, a didactic requirement, and the fact that it is not easy does not justify, by any means, its avoidance.

DEFINITION

Galeno in masterly manner described and defined the angina:

> . . . angina is a constriction of the throat with difficulty in breathing and in swallowing, accompanied by symptoms caused by the inflammation, false or true, of the throat and larynx [quoted from Castelli [2]].

In spite of the somewhat misplaced reference to larynx, the term "angina" is precise and expressive. It truly gives the idea of the inflammatory process diffused, generalized, located in the throat and attaining to all its corners. It is more than tonsillitis or pharyngitis. Zarniko,[3] referring to the terminology of the ailments of the throat, stated literally:

> Angina and pharyngitis can be separated, one from the other, only theoretically. In each case of pharyngitis the whole lymphatic system of the throat is affected. *By angina, therefore, is meant the affection* [and the italics are Zarniko's] *in which the inflammation of the adenoid complex appears in the first plane of the morbid picture.*

And he continues:

> Formerly it was believed that in the angina there was frequently inflammation of the isolated parts of the lymphatic ring of the throat, especially the palatine tonsil. A carefully systematized observation demonstrated that this would be the exception and that chiefly the pharyngeal tonsil is more frequently vulnerable to infection than was previously believed. Fein, on the other hand, exaggerates when he emphasizes that in angina all parts of the Waldeyer ring are affected *always* to the same degree and almost simultaneously.

The point of view of Zarniko, that only theoretically is it possible to separate angina and pharyngitis, is not acceptable. This is not true even in the cases of acute involvement, to say nothing of the cases of chronic involvement, even when taking into consideration, as the author has given one to understand, that angina and tonsillitis are the same

2. Castelli, B., and Bruno, J.: Lexic medicum graeco-latinum, editio nova, Geneva, Fratres de Tournes, 1746.

3. Zarniko, C.: Erkrankungen der lymphatischen Rachenringes, in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohrenheilkunde mit Einschluss der Grenzgebiete, Berlin, Julius Springer, 1928, vol. 3, p. 56.

thing. It is daily seen that in cases of inflammation of the throat the condition is more preponderant and much more intense sometimes in the tonsils and sometimes in the pharynx. For example, in pharyngitis granulosa the tonsil is not affected.

The German laryngologist is not right in his definition of angina. By his opinion it can be inferred that the angina must be the first manifestation of the disease. According to such a theory, the ulcero-necrotic angina of the hemopathies is not angina.

It is true that in tonsillitis, as well as in pharyngitis, the inflammatory process does not reach isolatedly one or another part alone of the lymphatic ring of the throat. Often an inflammation, the first signs of which appeared in the tonsil, extends to the surrounding parts, spreads through the whole throat and sometimes to the neighboring regions. All of this, however, does not impede admission of pure tonsillitis and pure pharyngitis. What happens here is similar to what is observed in the nasal fossae with regard to the paranasal sinuses, as well as in the tympanic cavity with relation to the attic, the antrum and the cells of the mastoid process: The phlogistic process is total. Who can deny, however, that in the space of a few days, sometimes of hours, it may not be more or less localized in one or another point of the middle ear? If a pure tonsillitis and a pure pharyngitis are not to be admitted, much less can one talk about a single acute maxillary or frontal sinusitis, or an acute otitis media or a mastoiditis. Even in an organ of much smaller dimensions, in which the various parts of its complex structure are intimately related, such as the eye, the inflammatory process localizes in much smaller points than the tonsil—in the iris, in the choroid, in the retina.

With regard to the throat it is obvious, as already stated, that the infection which in the beginning was diffused may later become localized; it may start in a circumscribed zone and later spread to the whole isthmus. There are processes, however, that develop almost exclusively in the tonsils, remaining restricted to these organs. There are others, also, which are limited to the pharynx. The tonsil is an anatomic, histologic and perhaps physiologic entity: an autonomous and independent organ, with its own pathology. The inflammation of this organ, therefore, must be tonsillitis (or amygdalitis). The pharynx, also, possesses an anatomic and pathologic individuality, so that its inflammation must be named pharyngitis. It would be just as illogical to include tonsillitis in pharyngitis as it would be to include pharyngitis in tonsillitis. The word "angina" as Galeno defined it is the total process, that is, the sum of tonsillitis plus pharyngitis:

$$\text{Tonsillitis} + \text{pharyngitis} = \text{angina.}$$

From my point of view this would be the logical and intuitive criterion which should per force be adopted in the nomenclature of the ailments of the throat.

If one takes this assumption as a starting point—and keeps in mind the existence of pathologic manifestations which are localized, if not exclusively, at least more intensely, either in the tonsil or in the pharynx and still others which are only found generalized in the isthmus of the throat—one must establish a separate classification for each kind; that is, a classification for tonsillitis, one for pharyngitis and a third for angina.

TONSILLITIS

Tonsillitis, pharyngitis and angina present great difficulties with regard to the chronic and the acute stages. This is the reason for the maintenance of the criterion of course in the great majority of the classifications, and it will be maintained throughout this paper.

Acute Tonsillitis.—There are seven forms.

1. Erythematocatarrhal: The following supposedly isolated types are herein included: erythematous, catarrhal, serous, mucous and mucopurulent. Congestion predominates simultaneously with transudation. There is no pure erythematous tonsillitis except theoretically. As soon as the erythema appears, the mucous glands are affected, and the secretion appears. The differences of this secretion, whether pure serum, mucus, mucus and serum or mucus and pus, are subtilties which do not withstand analysis and do not allow clinical differentiation.

2. Pultaceous: It is also called follicular, but this designation should not be maintained, as it conveys the idea of the limitation of the phlegmatic process to the follicles only, which is not correct. Some authors even designate by this name the cryptic or lacunar forms per se, although erroneously, as mentioned by Moore.[4] Fraenkel [5] expressed the opinion that "the designation follicular angina is best avoided," and Zarniko [3] agreed with the point of view of Aschoff [5] and of Kuttner [5] that on any inflammation of the parenchyma of the tonsil the follicles are affected. Marfan,[6] also, is opposed to the use of the word "follicular":

> The expression is absolutely defective. "Follicular angina" could mean only one thing: an angina with inflammation of the lymph follicles—not only those included in the tissues of the tonsil but those that exist isolatedly in the back part of the pharynx. In all cases of acute angina these follicles become inflamed, although sometimes more intensely than others. In some cases this folliculitis turns into a miliary abscess, which produces a small grayish tumefaction, then it drains and leaves a small crateriform or punctiform erosion, followed by rapid cicatrization. Finkelstein suggested that the name "follicular angina" must be

4. Moore, I.: The Tonsils and Adenoids and Their Diseases, Including the Part They Play in Systemic Diseases, St. Louis, C. V. Mosby Company, 1928.

5. Cited by Zarniko.[3]

6. Marfan, A. G.: Le diagnostic des angines aigues, Paris, Masson & Cie, 1929.

reserved for the processes which determine these small abscesses. This point of view cannot be accepted, as such abscesses do not constitute a separate and autonomous phenomenon; they can be seen, as not very important incidents, in all forms of angina in the catarrhal and especially in the lacunar, but also in Vincent's.

Tonsillitis

- Acute
  - I. Erythematocatarrhal
  - II. Pultaceous
  - III. Cryptic (or lacunar)
  - IV. Fibrinopurulent (or pseudomembranous)
    - 1. Diphtheritic
    - 2. Fusospirochetal (1st stage—Vincent's diphtheroid form)
    - 3. Pyogenic
      - (*a*) Streptococcic
      - (*b*) Pneumococcic
      - (*c*) Staphylococcic, etc.
  - V. Ulcerous
    - Primary syphilis
  - VI. Ulceronecrotic
    - Fusospirochetal (2d stage)
      - (*a*) Common
      - (*b*) Of the hemopathies
        - Leukemia
        - Agranulocytosis
        - Infectious mononucleosis
        - Aleukia
      - (*c*) Of the medicamentous intoxications (Bi, Hg)
  - VII. Abscessed
    - 1. Abscessed retention cyst
    - 2. Genuine abscess
- Chronic
  - I. Cryptic (or lacunar)
    - 1. Purulent
      - Simple
      - Cystic
    - 2. Caseous
    - 3. Corneous
    - 4. Calculous
  - II. Hypertrophic-hyperplastic
    - 1. Simple
    - 2. Of the hemopathies
      - (*a*) Leukemia
        - Common
        - Hemorrhagic
      - (*b*) Lymphogranulomatosis (Hodgkin's disease)
    - 3. Of the granulomas
      - (*a*) Syphilis
      - (*b*) Tuberculosis (Sabrazès' pseudolymphadenia)
  - III. Ulcerous
    - 1. Syphilis
    - 2. Tuberculosis
    - 3. Blastomycosis (paracoccidioidomycosis)
    - 4. Actinomycosis

The pultaceous—*puls, pultis,* pulp, poultice—form is the one which is characterized by the presence of purulent matter in the cavities of the crypt. Sometimes this purulent matter aggregates, forming a real cake, which differs from that of diphtheria in that it is easily removed and does not leave any sign in the epithelium—it is not a part of the epithelium; it is simply attached to that.

3. Cryptic (or lacunar): In this form of tonsillitis the process develops mainly in the crypts.

4. Fibrinopurulent: Tonsillitis of this character is called classically pseudomembranous. In fact, a formation appears over the organ which is similar to anatomic membranes—mucous, serous, cutaneous and others—but which in truth is nothing but a fibrinous net more or less full of inflammatory elements, especially polymorphonuclear leukocytes. It should be remembered that the Greek term *διψθόρα*, from which Bretonneau formed the term *diphtérite,* which was later corrected by Trousseau to *diphthérie,* means membrane.

There are three types of fibrinopurulent or pseudomembranous tonsillitis. The most characteristic is the diphtheritic. In the tonsillitis caused by the fusospirochetal symbiosis there is, also, a formation of fibrinopurulent patches, the initial character of which is pseudomembranous, this being the reason why Vincent called it a diphtheroid form. There are still other micro-organisms which produce false membranes: the streptococcus, the pneumococcus, Friedländer's bacillus, the micrococcus and others.

5. Ulcerous: There is only one type of acute ulcerous tonsillitis—the initial ulcer of syphilis, the syphilitic chancre of the tonsil. Some include in this form the fusospirochetal tonsillitis, or Plaut-Vincent's infection, known by the name of ulceromembranous tonsillitis, owing to the fact that the lesion is covered by a membrane. This, however, is not correct. The fusospirochetal ulcer is covered with or, rather, full of a putrid paste. This lesion may be called ulceronecrotic or ulcerosphacelic or ulcerogangrenous but never ulceromembranous.

6. Ulceronecrotic: A typical example is the Plaut-Vincent tonsillitis, often localized exclusively in the tonsils and generally in only one of them. As Escat[7] has stated, Vincent's tonsillitis is always secondary. The truth is that certain conditions diminish the general as well as the local resistance, aiding the pullulation and the increase of the virulence of the fusospirochetal symbiont, a common saprophyte of the mouth. One finds Vincent's tonsillitis grafted on the ulcerated gumma and on the ulcerated neoplasm; typical Vincent's tonsillitis may be provoked by the mercury or by the bismuth of various compounds used as medicines, so that the arguments as to the occurrence of pure Vincent's tonsillitis are insufficient. There are many patients whose care of their mouths is hygienic, who are not undernourished, who do not suffer from avitaminosis and who are not being treated with mercury or bismuth compounds in whom Vincent's tonsillitis appears with

7. Escat, E.: Caractères deutéropathiques de l'angine fuso-spirillaire de Vincent: Méconnaissance fréquente de la propathie antécédante, Arch. internat. de laryng. **34**:256 (Feb.) 1928.

typical and well defined characteristics. This type I should call common as it is the most frequently observed.

The type mentioned earlier in regard to cases of great local or general disturbance of the defenses and of the resistance one may call symptomatic or grafted. Such is the tonsillitis occurring in cases of mercury or bismuth intoxication, leukemia, granulocytopenia, aleukia, infectious mononucleosis (monocytic or lymphocytic angina or tonsillitis), also that in cases of ulcerated neoplasm or gumma.

7. Abscessed: There is a purulent process which is localized in the parenchyma of the tonsil which is a real abscess of the tonsil and not the phlegmonous process generally observed. One of the most common types of it is the retention cyst, later contaminated by pyogenic organisms. Fernández Vela,[8] in a recent study regarding the intrinsic abscess of the tonsil, mentioned the convenience of a histopathologic classification which would be more correct than the morphologic and which would prove the existence of three types: (*a*) cryptic empyema, (*b*) abscessed cyst and (*c*) the true intrinsic abscess.

Chronic Tonsillitis.—There are three forms.

1. Cryptic (or lacunar): As in the acute tonsillitis, the process is localized mainly in the epithelium of the crypts. Amersbach[9] stated that "the chronic tonsillitis is, first of all, a cryptotonsillitis," which was recently emphasized convincingly in a paper written by Thiessbürger,[10] of the Aschoff Institute.

In the chronically involved crypts one may see (*a*) pus; (*b*) *caseum* (from which is originated the name "caseous tonsillitis," which is nothing but a variation of the cryptic form); (*c*) a solid corneous substance, about which I shall speak later; (*d*) calcareous concretions, true calculi (called amygdaloliths, or tonsilloliths).

The majority of authors describe as mycosis of the tonsils (pharyngomycosis or tonsillomycosis) a process that is characterized, from the tonsillar crypts to the pharyngeal cavities, by projecting white or yellowish spicules, closely adhering to the organ and giving it a bristly and thorny aspect. Many authors—Fraenkel,[11] Heryng,[11] Chiari,[11] Laurens,[11] Lannois,[11] Guisez [11]—have expressed the belief that these spicules are formed of true colonies of fungi, generally of the genus Leptothrix. This is still the point of view of the great majority of specialists.

Such, however, is far from being correct. Siebenmann was the first to attribute the process to an intense proliferation of the malpighian

8. Fernández Vela, U.: Contribution to the Study of Latent Intrinsic Abscesses of the Faucial Tonsil, Rev. clín. españ. **10**:261 (May) 1943.

9. Amersbach: Zur Tonsillenfrage, Zentralbl. f. Hals-, Nasen- u. Ohrenh. **20**:410, 1933.

10. Thiessbürger, cited by Amersbach.[9]

11. Cited by Podestá and Games.[12]

layer of the mucosa. Podestá and Games [12] came to the same conclusion in recent studies, in which it was proved that the spicules are not constituted of colonies of fungi but of accumulations of corneous substance originating from the mucous membrane of the crypts as well as from the surface of the tonsil. Not only Siebenmann [5] but Podestá and Games, as well, and later Monserrat and Tato [13] came to the conclusion that Leptothrix has no pathogenic part in the process. There are various micro-organisms in the mass of the spicules and, among them, Leptothrix, all representing merely saprophytes. The hyperkeratosis is due, according to Anthon,[11] to a supposed Bacillus keratosus or, according to Wissokowicz,[11] to Friedländer's bacillus. Monserrat and Tato [13] were unable to find any such bacilli in their cases.

The truth is that it is strange that in these formations fungi are always present, some of the genus Leptothrix, others of the genus Candida, although the morphologic aspect may present certain differences. Of 2 cases in which examination was carried out, in the one caused by Candida there were no spicules but rather small globules in the opening of the crypts, resembling wax droplets.

I do not see how it can be proved that the presence of the fungi is due simply to chance, nor do I understand how it can be assumed that the hyperkeratotic process is completely independent of the presence of Leptothrix. It is highly possible that the irritation of the corneous layer of the mucosa is secondary and consecutive to the proliferation of the fungi, although such a histologic lesion is not found in the mycoses in general.

As the spicules have a corneous structure, I believe one could designate this tonsillitis by the name "cryptic corneous tonsillitis" (in accordance with cryptic purulent, caseous, calculous).

2. Hypertrophic-hyperplastic: In this class there is only the simple type. The processes found in the blood dyscrasias, the granulomas, the neoplasms, are hyperplastic. In the blood dyscrasias there are the simple type and the hemorrhagic. In a case of the latter, the only one which I have had the opportunity of seeing to date, the tonsils (only the tonsils) were enormous and purple colored, as if there was a submucosal blood suffusion. It was associated with acute lymphatic leukemia in a child about 14 years old, who survived a little over fifteen days.

3. Ulcerous: This is represented by: the ulcerated gumma of the tonsils; by the torpid forms of tuberculosis, often limited to one of

12. Podestá, R., and Games, F.: On Pharyngeal Hyperkeratosis, Rev. argent. de especialid., 1931, no. 2, p. 6.

13. Monserrat, J. T., and Tato, J. M.: Tonsillar Hyperkeratosis, Rev. Asoc. méd. argent. **4**:214, 1933.

the crypts; by the initial process with tendency rapidly to invade the pharynx, of the Brazilian blastomycosis (paracoccidioidomycosis), and, also, in very rare cases, by actinomycosis, of which Tao's [14] is a good example.

PHARYNGITIS

The classification of pharyngitis cannot follow this line, as the inflammations of the pharynx are, of course, more limited as to the number of forms.

Acute Pharyngitis.—Of acute inflammations of the pharynx, there are five outstanding forms.

1. Erythematocatarrhal (or simple): This form is frequent in the acute intoxications due to such substances as mercury, bismuth, arsenic and gold.

2. Follicular: In this form the process, although affecting nearly the whole pharynx, is more evident in the lymph follicles, more or less isolated, which are distributed on this part of the aerodigestive tract. Here the name "follicular" is well applied, as the inflammation is of the follicles, making them quite visible.

3. Ulcerous: The acute ulcerous pharyngitis may be localized in the front pillars as happens in Duguet's ulcer (improperly and unduly called Duguet's angina). It is constituted of small shallow ulcers, elliptic in form, with a great axis parallel to the rim of the anterior pillars, generally bilateral and symmetric. These ulcers appear in the first seven days of typhoid and are characteristic of this disease, helping to confirm the diagnosis.

Another type of ulcerous pharyngitis is found as the initial lesion of syphilis, although this rarely appears in the pharyngeal region.

4. Hemorrhagic: Apoplexy of the uvula serves as an example. The bleeding may remain restricted to this small appendix, or it may spread to the soft palate and the pillars, with resulting difficulty in swallowing and breathing, although this involvement is not an angina, since the process is limited. I wish to direct attention to the fact that in this group is included the condition observed by Predescu-Rion,[15] in which there was not a blood suffusion but rather an edema of the soft palate, the pillars, the epiglottis and the aryepiglottic folds, a process which had already been observed four times. Although it has been attributed to atmospheric conditions, to disturbances of the sympathetic nerves and to simple nervous manifestations, it seems clear that it is an allergic condition.

14. Tao, L.: Actinomycose primitive de l'amygdale, Bull. Soc. belge d'otol., rhin., laryng., July 1937, no. 3, p. 303; Zentralbl. f. Hals-, Nasen- u. Ohrenh. **30**:614, 1938.

15. Predescu-Rion: Oedème apoplectique du vestibule pharyngo-laryngien, Arch. internat. de laryng. **34**:225 (Feb.) 1928.

5. Phlegmonous: This is the case of the suppurative adenitis of the retropharyngeal lymph nodes, called Gillette's glands. Once released by rupture, the secretion spreads over the back wall and forms the retropharyngeal phlegmon, generally found in first childhood.

Chronic Pharyngitis.—The chronic inflammations of the pharynx take four forms:

1. Erythematous (or simple): This is really a case of erythema, of local congestion. The process is more or less localized. It consists

Pharyngitis

- **Acute**
  - **I. Erythematocatarrhal—of acute intoxications**
    1. **Mercury**
    2. **Bismuth**
    3. **Arsenic**
    4. **Gold**
  - **II. Follicular**
  - **III. Ulcerous**
    1. **Duguet's (typhoid)**
    2. **Primary syphilis**
  - **IV. Hemorrhagic**
    Apoplexy of the uvula and of the soft palate
  - **V. Phlegmonous**
    Posterior pharyngeal phlegmon (Gillette's lymphatic glands)
- **Chronic**
  - **I. Erythematous (or simple)**
    Circumscribed, limited to the anterior pillar (Bourgeois's sign)
  - **II. Ulcerous**
    1. **Syphilis (secondary and tertiary)**
    2. **Tuberculosis**
    3. **Leishmaniasis**
    4. **Blastomycosis (paracoccidioidomycosis)**
    5. **Leprosy**
    6. **Scleroma**
  - **III. Hyperplastic**
    1. **Diffuse**
    2. **Circumscribed**
       (*a*) **Lateral**
       (*b*) **Granulous**
  - **IV. Atrophic (or hypoplastic)**
    1. **Ozenous**
    2. **Diabetic**

of a redness of the anterior pillars, which appear as if painted with a brush.

In their extensive treatise on the tonsils, Worms and Le Mée [16] refer to an "edematous redness of the anterior pillar" or a "dark red streak of the pillar" as "a characteristic sign, which is always present," of the inflammatory state of the subjacent tonsil. Bloch and Bouchet [17] gave this streak the name "Bourgeois's sign."

16. Worms, G., and Le Mée, J. M.: Les foyers amygdaliens, Paris, Imprimerie Chantenay, 1931.

17. Bloch and Bouchet, cited by Worms and Le Mée.[16]

In this sign there are redness and edema. I have seen, many times, this irritation of the pillar due to chronic inflammation of the tonsil.

2. Ulcerous: Chronic pharyngeal ulcers are frequent and are generally due to granulomas or to neoplasms. Syphilis (secondary as well as tertiary), tuberculosis, leishmaniasis, blastomycosis (paracoccidioidomycosis), leprosy and scleroma produce ulcerous lesions of the pharynx, without affecting the tonsils.

3. Hyperplastic: The hyperplasia (and not hypertrophy) may be generalized, as happens in the smoker's pharyngitis, or it may be localized. The latter includes two types: the process limited to the lateral pharyngeal bands—lateral pharyngitis—and the one limited to the follicles of the back wall—granulous pharyngitis.

4. Atrophic (or hypoplastic): This is observed in the condition known as pharyngitis sicca—for example, that secondary to ozenous atrophic rhinitis. Joal,[18] in his book, cited diabetes as a frequent cause of pharyngitis sicca. Many authors have not agreed with this opinion, but Blummenfeld [19] recently noted several cases in which the diagnosis of diabetes was suggested by pharyngitis sicca and confirmed by laboratory tests.

ANGINA

Angina, naturally, covers a much wider classification.

Acute Angina.—Here there are seven forms.

1. Erythematopultaceous: In angina, the process being more intense and diffused, the erythematocatarrhal phase fuses with the pultaceous. This is seen in the anginal processes of the acute infectious diseases—measles, scarlet fever, influenza, typhoid, acute articular rheumatism and others.

2. Vesicular: The tonsils, the posterior wall, the soft palate and the uvula, in the vesicular angina, are covered by small vesicles full of liquid. If the liquid is transparent and the condition, which sometimes can reach the buccal mucosa, is present on only one side, the term is "zona" (herpes zoster). If, however, the liquid is serous and the process is not located on one side in particular, the term is "herpes simplex" or "herpetic angina." Marfan [6] stated that he did not believe in the occurrence of this angina: "The cases which our colleagues consider as herpetic angina, we diagnosticate as cryptic angina." Dieulafoy [20] described it in his unique manual but said that "herpetic

18. Joal: L'angine sèche, Paris, 1883; cited by Blummenfeld.[19]

19. Blummenfeld, F.: Akute und chronische Pharyngitiden, in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohrenheilkunde mit Einschluss der Grenzgebiete, Berlin, Julius Springer, 1928, vol. 3.

20. Dieulafoy, G.: Manuel de pathologie interne, ed. 13, Paris, Masson & Cie, 1901.

Acute

1. Erythematopultaceous—of infectious diseases (measles, scarlatina, influenza, etc.)

II. Vesicular
   1. Phlyctenular (herpes simplex and herpes zoster)
   2. Pustular (angina pustulosa primitiva—Marfan)

III. Edematous
   1. Allergic
   2. Fluxionary (rheumatismal)

IV. Fibrinopurulent (or pseudomembranous)
   1. Diphtheritic
   2. Fusospirochetal (1st stage—Vincent's diphtheroid form)
   3. Pyogenic
      (*a*) Pneumococcic
      (*b*) Streptococcic
      (*c*) Staphylococcic, etc.
   4. Mycotic (Leptothrix, Oidium, etc.)

V. Ulcerous
   1. Diffuse—acute miliary tuberculosis (Isambert's disease)
   2. Circumscribed—aphthous
      (*a*) Common aphthae
      (*b*) Epizootic aphthae

VI. Ulceronecrotic
   1. Fusospirochetal (2d stage)
      (*a*) Common or simple
      (*b*) Of the hemopathies
         Leukemia
         Agranulocytosis
         Infectious mononucleosis
         Aleukia
      (*c*) Of medicamentous intoxications (Bi, Hg)
      (*d*) Of hypovitaminoses
   2. Henoch's
      (*a*) Primary
      (*b*) Postscarlatinal, postdiphtheritic

VII. Phlegmonous
   1. Superior
   2. Inferior
   3. Posterior

Chronic

I. Erythematous
   1. Tobacco
   2. Iodide intoxication
   3. Salicylate intoxication
   4. Diabetes
   5. Uremia
   6. Syphilis (vermilion erythema)

II. Cryptic
   Corneous

III. Ulcerous
   1. Syphilis
   2. Tuberculosis
   3. Leishmaniasis
   4. Leprosy
   5. Scleroma
   6. Blastomycosis (paracoccidioidomycosis)
   7. Actinomycosis

IV. Infiltrative
   1. Tuberculosis (sclerema form)
   2. Syphilis (sclerema form)

angina as understood by our ancestors should be put aside: there is, in reality, no herpetic angina, but angina with herpes." There is no doubt, however, that herpes may affect the throat, in the region of the soft palate and pillars as in the tonsils, and has there a characteristic aspect. I had occasion to observe 2 typical cases.

If the liquid becomes purulent, one sees the pustular form, an example of which is Marfan's "primitive pustular angina," characterized by the presence of real pustules of the size of a lentil, full of "frankly purulent liquid—and not seropurulent as in the varicella vesicles" (Marfan). The vesicles are usually isolated, but may conglomerate, as this condition is found principally in the surface of the tonsils.

The first type, of small vesicles, the herpes simplex and the herpes zoster, may be designated by the name "phlyctenular;" the second, by "pustular."

3. Edematous: In cases of allergy there is observed superacute edema of the whole throat. Jovino Faria informed me of a case of this type (food allergy—chocolate, shrimp).

Another type of edematous angina is the fluxionary angina, the old Trousseau's arthritic angina, a real palatal pseudophlegmonous inflammation of rheumatic origin, which has its only treatment in the use of the salicylates. Its aspect is that of a peritonsillar abscess—sore throat with the pain irradiating to the ear, trismus, velopalatine flux. Puncture, even if made repeatedly, always gives negative results (i. e., one does not obtain pus). Canuyt and Chaumerliac [21] isolated this characteristic rheumatic angina, and Almeida Reboucas, of Vitoria, Brazil, had occasion to observe 2 cases of it.

4. Fibrinopurulent: The types are the same as observed in tonsillitis (diphtheritic, fusospirochetal, pyogenic). At this point it should be emphasized that if the diphtheritic angina is more frequent than the diphtheritic tonsillitis, the opposite is observed with regard to the Plaut-Vincent amygdalitis, generally designated by the name of angina.

Besides these types there is the mycotic, characterized by the presence, in the mucous membrane of the throat, of sparse spots, similar to clabbered milk. It generally is oidiomycosis. According to Podestá and Games, Fürbringer described real leptothricotic angina, in which, from material collected from the spots dispersed through the tonsils, the pillars and the soft palate, developed colonies of Leptothrix buccalis.

5. Ulcerous: The acute ulcerous processes localized in the throat may be diffused or circumscribed. Of the first type is the acute miliary tuberculosis of the pharynx (Isambert's disease) with two forms,

21. Canuyt, G., and Chaumerliac, J.: Sur deux cas d'angine rhumatismale simulant un abcès peri-amygdalien, Arch. internat. de laryng. **33**:295 (March) 1927.

the superacute, described by Letulle, and the subacute, by Escat.[22] The aphthous angina is of the circumscribed form. According to the classics, the aphtha starts with a vesicle of short duration. Thus the aphthous angina should perhaps be classified as the vesicular. It happens, however, that this angina is not characterized by the blistering stage, which I never had an opportunity to observe, but by a small ulcer, circular or oval, covered by a yellowish membrane, which appears irregularly in the soft palate, the pillars or the posterior pharyngeal wall, a typical ulcer, which was denominated aphtha. It is my opinion, therefore, that the condition should be classified as ulcerous.

In the aphthous angina one must include two types: aphtha vulgaris (or symptomatic aphtha) and aphthous fever. The main difference between these two conditions is the general reaction of the organism, nonexistent in the first case.

6. Ulceronecrotic: This comprises two types: (*a*) the fusospirochetal angina, which may be autonomous or, say, primary, or may be a mere complication of a hemopathy or of any ulcerous lesion, and (*b*) Henoch's necrotic angina. This angina was described in 1885, according to Hutinel,[23] by the German pediatrician Henoch, as a somewhat frequent complication of scarlet fever, under the name "necrotic inflammation." However, Stroé and Hortopan [24] demonstrated recently that this angina may be primary. As it is a little known type, a somewhat lengthier description of it becomes necessary.

Henoch's angina shows a certain similarity to the Plaut-Vincent angina. Certain writers—among them Bezançon,[25] Philibert [25] and Bokay [25]—have considered the two processes as identical or at least very similar. Stroé and Hortopan, however, found the two conditions clearly different not only in the clinical but in the bacteriologic and the therapeutic aspects. As it happens, in the gangrenous pulp of the lesion the fusospirochetal symbiosis was never found in the research, nor did the process suffer the smallest influence through the use of neoarsphenamine. The simple cultural examination never turned up anything worthy of being mentioned. In the cultures made in anaerobic mediums, however, Bacillus (or Clostridium) perfringens predominated in the majority of cases and, in some, Bacillus (or Clostridium) oedematiens, which led the writers to the conclusion that these microorganisms play a leading, if not exclusive, role in the genesis of the primary necrotic angina.

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22. Escat, E.: Traité médico-chirurgical des maladies du pharynx, Paris, G. Carré & C. Naud, 1901.

23. Hutinel, V.: Les maladies des enfants, Paris, Asselin & Houzeau, 1909, vol. 3, p. 90.

24. Stroé, A., and Hortopan, D.: L'angine nécrotique primitive, Presse méd. **43**:182 (Feb. 2) 1935.

25. Cited by Stroé and Hortopan.[24]

The process starts with a small white, opaque or grayish spot as if the mucous membrane had suffered in that point the caustic action of silver nitrate. Hutinel has insisted on this comparison, which is exact in the opinion of Stroé and Hortopan:

> In the majority of cases, the first points appear in the upper pole of the tonsil, and from there the process expands rapidly, as if it were an oil spot, to the pillars, the uvula, the soft palate, the cavum, the tonsils, the mucous membrane of the cheeks.

The lesions are bilateral and symmetric.

It becomes obvious from the foregoing description that Henoch's angina is a defined morbid entity and should, therefore, be included in the nosology of the throat.

7. Phlegmonous: As I have indicated in the classification of tonsillitis, a purulent collection may be limited to the tonsil's parenchyma. Generally, however, the pus affects the peritonsillar tissues and tries to spread to the neighboring regions. There are then not abscesses but real diffuse phlegmonous processes, which prevail more often in three nitid regions—superior (intravelum), posterior and inferior—all of these types causing great difficulty in swallowing and, not rarely, in breathing.

Chronic Angina.—There are only four forms of chronic angina.

1. Erythematous: In this case the picture hardly changes. Hyperemia, more or less intense and diffuse, is observed. It is enough to look at the throat of certain smokers. One sees the same picture with small variations in iodine and salicylate intoxications and especially in uremia and to a smaller degree in diabetes. Syphilis may manifest itself through this characteristic vermilion-colored erythema. Dieulafoy has called attention to this fact:

> Syphilitic angina of erythematous form, characterized by diffused or restricted erythema of the soft palate, pillars, tonsils which erythema frequently takes vermilion coloring, very well described in the thesis of one of my pupils (Benoist, Thèse de Paris, 1890). The vermilion (or cynabrium) erythema deserves to be well known, as it per se may help the diagnosis; this is a fact which I have observed several times.

And all will agree with this opinion of the great master.

2. Cryptic: Here one finds only a corneous type, improperly attributed by many authors to fungi. The lesion, in general of the palatal and lingual tonsils only, more rarely of these and of the pharynx, extends in still less frequent cases to the follicles of the posterior wall of the pharynx.

3. Ulcerous: This term describes the diffuse anginal processes of such diseases as tertiary (and also secondary) syphilis, tuberculosis, leishmaniasis, blastomycosis and scleroma.

4. Infiltrative: The so-called sclerematous form of tuberculosis of the pharynx serves as a type, in which is perceived by touch a hard hyperplasia of nearly cartilaginous consistency, of the uvula, the soft palate, the pillars and the posterior wall of the pharynx. I observed a similar aspect in a certain case of tertiary syphilis in which the disease was resistant to bismuth. The process was connected to an ulcerated gumma of the soft palate and was unilateral.

Forms Not Included.—Many denominations and forms mentioned by authors are not included in the classification which I have just described.

The pemphigoid angina mentioned by Moure and Brindel [26] is one of them. It may be that in pemphigus there are blisters in the throat, but this does not justify the creation of a type of angina. I shall say the same of the supposed variolar and varicellic angina.

Erysipelatous angina, if it occurs, is included in the streptococcic conditions of the throat. There are writers who consider the phlegmonous processes as erysipelas of the throat.

The impetiginous form is another the inclusion of which was not maintained in the division I organized.

Moure's simple ulcerous angina (or acute lacunar ulcerous angina) is not included, as it is a process which is subject to discussion. Moure [27] described it as the final phase of cystic angina, that is, the consequence of the rupture of a retention cyst. From my point of view the process is cryptic tonsillitis of a cystic form in its final phase, and consequently I believe that one should take into account only its capital phase, the cyst.

Gouty angina does not occur as a special type. As Kyle [28] said:

> . . . the variety of inflammation of the tonsils resultant from such cases has no special form. It may be a superficial, a cryptic or the supposed parenchymatous amygdalitis, which affects the whole organ.

I did not follow Escat's division in regard to his three types of herpes—infectious herpes, zona (herpes zoster) and recidivant herpes—as they do not seem to be of indisputable standing. Lermoyez [29] said: "The herpetic angina is not a specific affection; it is nothing more than a mode of reaction of the throat to various germs." Today one admits the common herpes and herpes zoster.

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26. Moure, E. J., and Brindel, A.: Guide pratique des maladies de la gorge, du larynx, des oreilles et du nez (cavités accessoires comprises), ed. 2, Paris, O. Doin, 1914.

27. Moure, cited by Moure and Brindel.[26]

28. Kyle, D. B.: Text-Book of Diseases of the Nose and Throat, ed. 5, Philadelphia, W. B. Saunders Company, 1915.

29. Lermoyez, cited by Escat.[22]

Neither the lingual nor the pharyngeal tonsils were included in this classification, as otherwise the whole of Waldeyer's lymphatic ring, which covers even the larynx, would have to be included. The pharyngeal tonsil was excluded because it does not form part of the throat. The pathology of the lingual tonsil was not studied, for it is identical with that of the faucial tonsil and that of the pharynx.

COMMENT

The foregoing classification does not serve to separate by definite, mathematical delimitations the various morbid entities and the various types of the same ailment which appear in the throat. It is logical that this is impossible in pathology. The classification has in view almost exclusively to orientate and, above all, to clarify and make less unprecise one of the most obscure and controversial problems of laryngology. Constructive criticism will, I am sure, improve the classification which has just been proposed for the throat diseases.

SPEECH HEARING IN OTOSCLEROSIS

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IN OTOSCLEROSIS we noted a characteristic pattern of response to word-hearing tests. This statement concerns only those cases in which there is little involvement of the inner ear, and no aphasia. The striking feature in these cases is the greater proportionate speech-hearing loss, which is more marked for words of the low frequency range. While the air conduction audiograms of 3 different patients may show equal degrees of pure tone deafness, the word-hearing test will help in making a differential diagnosis between otosclerosis, on one hand, and nerve deafness and chronic adhesive otitis media, on the other. Horizontal bargraphs, which are most helpful in depicting these points, are employed by us in recording word-hearing tests.

Essentially, the ability to hear speech indicates that at the level of 30 to 50 decibels of intensity above threshold the auditory mechanism functions satisfactorily. Pure tone audiometry, on the other hand, delineates only threshold perception and does not measure the extent of the loss of the function of loudness in deafness. Other important factors are word memory and word association, their centers being located in the temporal lobe and the subcortical association regions, respectively. If one shouts into the ear of a profoundly deaf person, he will often guess a familiar word, even though only a few of its component sounds are heard. A backwoods painter, whose audiogram showed a 90 decibel loss to all discrete frequencies, could hear the words "red," "green," "blue" and "yellow" when these were recited loudly and repeatedly into his ear, but he could not make out without lip reading a word less often used by him, no matter how intensively it was shouted. It must be brought home, therefore, that speech-hearing tests must be made with only the most common words. Coming now to the function of frequency, we recall that a person's threshold for various tones may vary widely; similarly, the loudness loss is often most pronounced in a

From the Department of Otorhinology, Temple University School of Medicine.

Read at the Seminar on Rhino-otology, Temple University School of Medicine, April 25, 1946.

specific portion of the speech frequency range. It follows that one is justified in postulating that a word made up of syllables which fall within a certain band of frequencies will not be heard by one whose threshold deafness extends into that range, provided there is a loss in the loudness function at the same time. Ordinarily, augmenting loudness will go a long way in making up for a deficiency in the function of frequency, as every increment of increase in intensity will set a correspondingly wider area of the basilar membrane into vibration. When these considerations are applied to speech, the specific attributes of the spoken word, with its distinctive aural cues of recognizability, add up greatly to the increase of hearing, so much that, often enough, a person whose audiogram shows a 50 per cent disability by the tables of the American Medical Association will actually have only a 15 per cent loss of hearing for spech.

In contrast, the otosclerotic patient usually has a greater loss of hearing for words than his audiogram would indicate. His central perception is normal; his word memory and word association tracts are not at fault. His vocabulary is adequate, and he modulates his voice normally. If he fails to hear the spoken word in spite of his superb ability to recall it to memory by the available cues, it is because it is not transmitted to his ear loudly enough. From our studies we are convinced that word-hearing tests demonstrate in otosclerosis not only an over-all loudness loss but also a great degree of deafness for words falling within the lower frequency range.

For this study a soundproof room was found unnecessary, as the differential diagnosis concerns patients whose audiograms show a loss greater than 30 decibels in all frequencies. However, our testing room is located in the most silent part of the building, and the door leading into it from the waiting room is double and is equipped with clamps to close it tightly against heavy felt pads on the door jambs.

The patient and the tester are seated in the center of the room, 4 feet (about 1 meter) apart, with the chairs so arranged that the ear to be tested is at an angle of 90 degrees to the voice and at a shorter distance from any reflecting surface, while the other ear is plugged and heavily covered. Average conversational voice is employed with patients whose audiograms show a loss of about 35 to 40 decibels in the speech range, while the voice is increased in strength when the decibel loss is greater. To be more specific, a moderately strong voice is used with a patient whose average threshold is at 50 decibels, while shouting is required for one whose loss is 65 decibels. The test words are grouped into two lists. Common words of the lower frequency range constitute list 1, while words containing sounds with frequencies higher than 2500 double vibrations make up list 2.

LIST 1

along	rule	all	ray	wool	ring	lure	wing
roll	mom	woe	army	warm	hole	win	men
hay	lion	her	lawn	wine	lamb	lily	me
how	oil	our	home	lime	hill	no	or
hen	honey	ear	only	name	moon	earn	honor
mill	air	lay	mail	hire	lean	heal	near
hero	away						

LIST 2

fish	safe	thick	zip	thief	thrift	six	sheep
spin	stable	fast	saw	think	zeal	its	thirst
spite	spit	fall	fit	this	is	his	flag
so	has	fix	most	soap	soup	son	first
zoo	thin	sale	soft	sore	say	fat	foot
face	sac	thing	zero	thirty	fool	sin	force
third	sit						

Charts 1 to 3 illustrate our findings in three representative cases. Soft conversational voice at a distance of 4 feet was employed in testing these patients.

Chart 1 shows the records of a young woman, E. R., aged 22, whose deafness was discovered through a school test at the age of 13. There is no history of any trouble referable to the ears, the nose or the throat, and no abnormality was disclosed on examination. The eustachian tubes were patent. The Rinne test was negative, and the loudness balance test showed no recruitment.

The word-hearing loss was 52 per cent in the right ear and 40 per cent in the left ear for list 1 and 38 and 32 per cent, respectively, for list 2. Pure tone hearing in the lower frequencies was comparatively better.

Chart 2 shows the results of tests made on a veteran, T. S., aged 25, an aural casualty from gunfire at close range. He gets along well without a hearing aid. Otoscopy, rhinoscopy and nasopharyngoscopy revealed no abnormality. The eustachian tubes were patent. The Rinne test was positive, and recoupment was present in the loudness balance test.

In the word-hearing test, the loss was 20 per cent in the right ear and 18 per cent in the left ear for list 1, whereas for list 2 it was 30 per cent in each ear. His audiogram shows a disability of 53.2 per cent in the right ear and 44.5 per cent in the left ear, according to the tables of the American Medical Association.

In chart 3 are the records of a man, J. F., aged 39, whose left ear presents the typical clinical findings of chronic adhesive otitis media. Nasopharyngoscopy showed nothing of importance. The Rinne test was plus-minus, and the loudness balance test showed recoupment.

For the word-hearing test, the right external acoustic meatus was packed with petrolatum gauze, and the ear was covered with a jar filled with cotton. The patient's left ear was directed toward the tester, whose lips were protected by a shield to prevent lip reading. For list 1

the hearing loss was 10 per cent, while for list 2 it was 14 per cent. The audiometric loss ranged from 35 to 55 decibels for the speech frequencies.

In an advanced case of otosclerosis the responses to the word-hearing tests are more characteristic and striking. The outstanding difficulty is that speech must be transmitted to the ear louder and louder as time goes on. However, the patient retains aural cues normally and is conscious of slight variations in his own voice, which he modulates correctly. His tolerance for intensity is characteristic. In the normal person 1 decibel

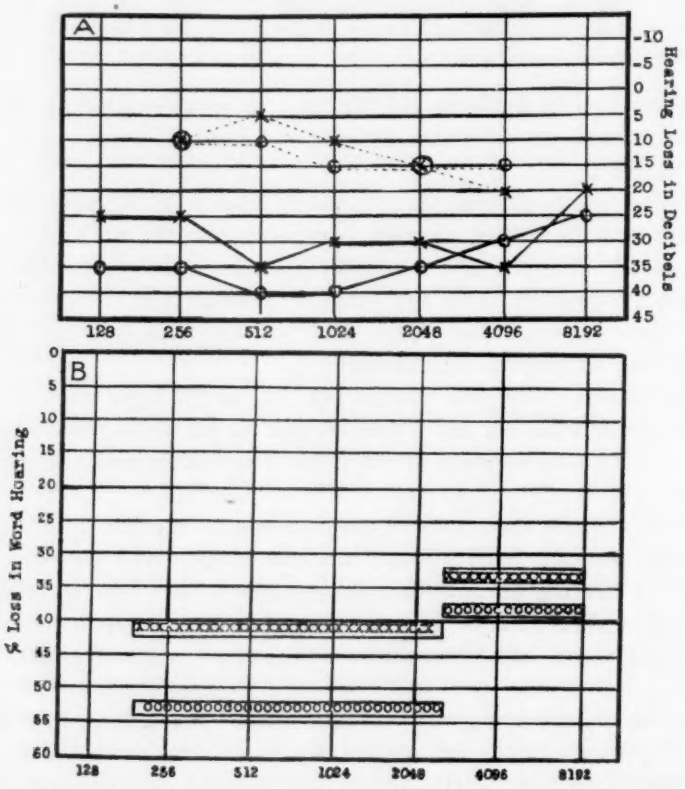

Chart 1 (case 1).—*A*, audiogram of E. R. Solid lines represent air conduction; dotted lines, bone conduction. Circles represent the right ear; crosses, the left ear. The percentages of disability according to the tables of the American Medical Association are: right ear, 40.8; left ear, 27.7. *B*, bargraph of word hearing of E. R. Circles represent the right ear; crosses, the left ear.

of sound intensity will activate a number of auditory nerve fibers to produce the conception of a certain degree of loudness, whereas in the otosclerotic patient 2 decibels will frequently be required to bring about the same effect. Only amplified sound can override the blockage at the stapedial footplate, but a great deal of this increased intensity is spent in crossing the obstruction, so that when the cochlea is reached, only a

fraction of the amplification, at the source of the sound, is at hand to activate nerve fibers of loudness. As from a practical standpoint we are mostly concerned with those patients who have little involvement of the inner ear, the operable ones, loudness will be normally proportionate to the strength of the stimulus reaching the cochlea. The patient with advanced otosclerosis will tolerate great intensity, as the strength of the amplification does not affect the inner ear, the force spending itself in

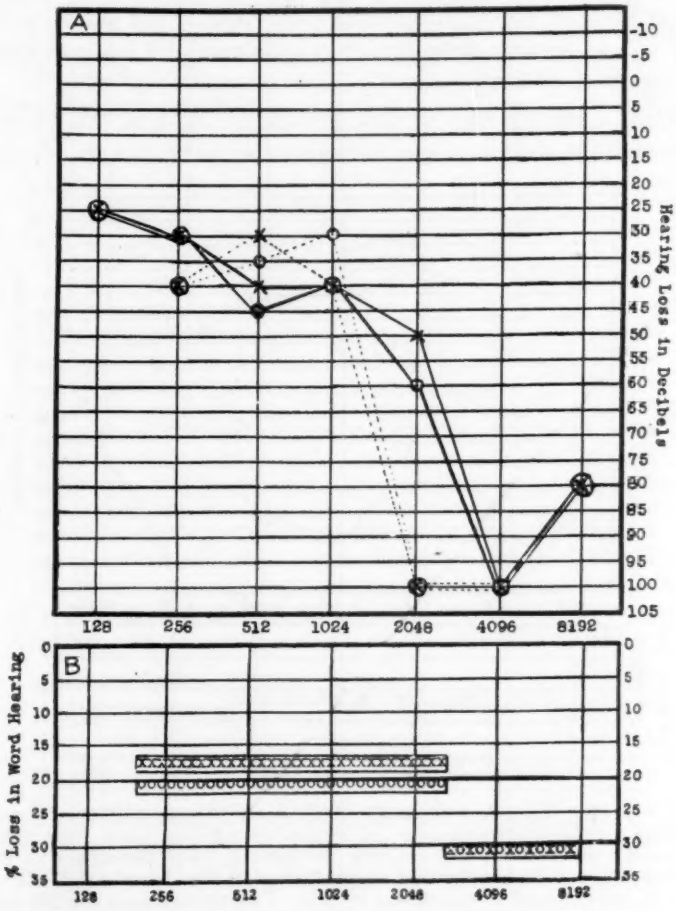

Chart 2 (case 2).—*A*, audiogram of T. S., whose deafness was the inner type. Solid lines represent air conduction; dotted lines, bone conduction. Circles represent the right ear; crosses, the left. The percentages of disability according to the tables of the American Medical Association are: right ear, 53.2; left ear, 44.5. *B*, bargraph of word hearing of T. S. Circles represent the right ear; crosses the left ear; crosses and circles, either ear.

penetrating a thick wall. On the other hand, in perceptive deafness, when some fibers along a certain frequency band are degenerated and are inadequate to contribute to the function of loudness, it is then by

increased intensity that adjacent areas on the basilar membrane are made to vibrate, thereby bringing about recoupment of loudness. The stimulus, however, is practically the same at the source and in the inner ear, and, therefore, the limitation of tolerance is at a lower level.

The recruitment of loudness also extends from one ear to the other. In perceptive deafness we found invariably that the patient hears speech much better with both ears than with either ear alone.

Representative cases, illustrating these points, are shown in charts 4 and 5. A moderately strong voice at a distance of 4 feet was employed in testing these patients.

In chart 4 are the records of a woman, D. Z., aged 40, whose deafness dates back sixteen years, following the birth of a child, and has

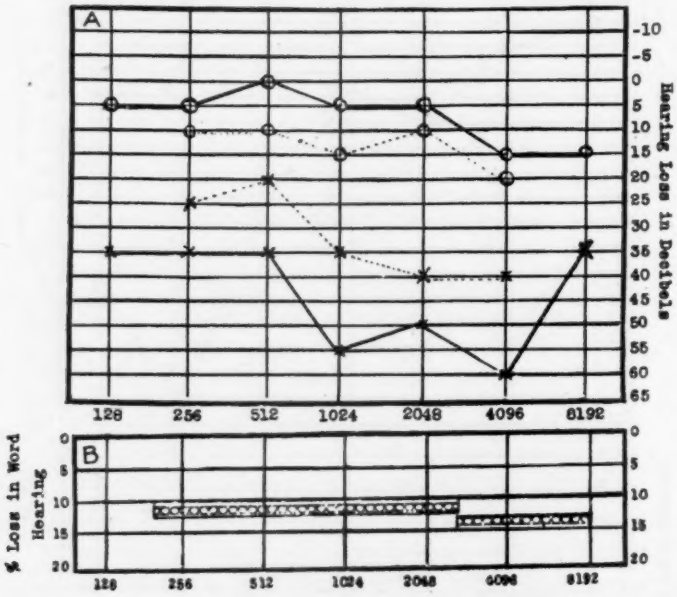

Chart 3 (case 3).—*A*, audiogram of J. F., a patient with chronic adhesive otitis media. Solid lines represent air conduction; dotted lines, bone conduction. Circles represent the right ear; crosses, the left ear. The percentage of disability of the left ear was 51.3, according to the tables of the American Medical Association. *B*, bargraph of word hearing of J. F. Crosses represent the left ear.

become progressively worse. Nasopharyngoscopy gave negative results, and the eustachian tubes are patent. No recruitment was present in the loudness balance test, and the Rinne test was negative.

The word hearing loss was 80 per cent in the left ear and 74 per cent in the right ear for list 1 and 60 per cent and 52 per cent, respectively, for list 2. By the tables of the American Medical Association, the percentage loss for discrete frequencies was 76.4 in the left ear and 58.2 in the right.

By means of the microphone circuit of the Maico audiometer, speech was amplified, and improvement in hearing was noted when the intensity was set at 70 decibels. When the intensity was raised to 90 decibels, the patient reported most comfortable hearing, and the score for both

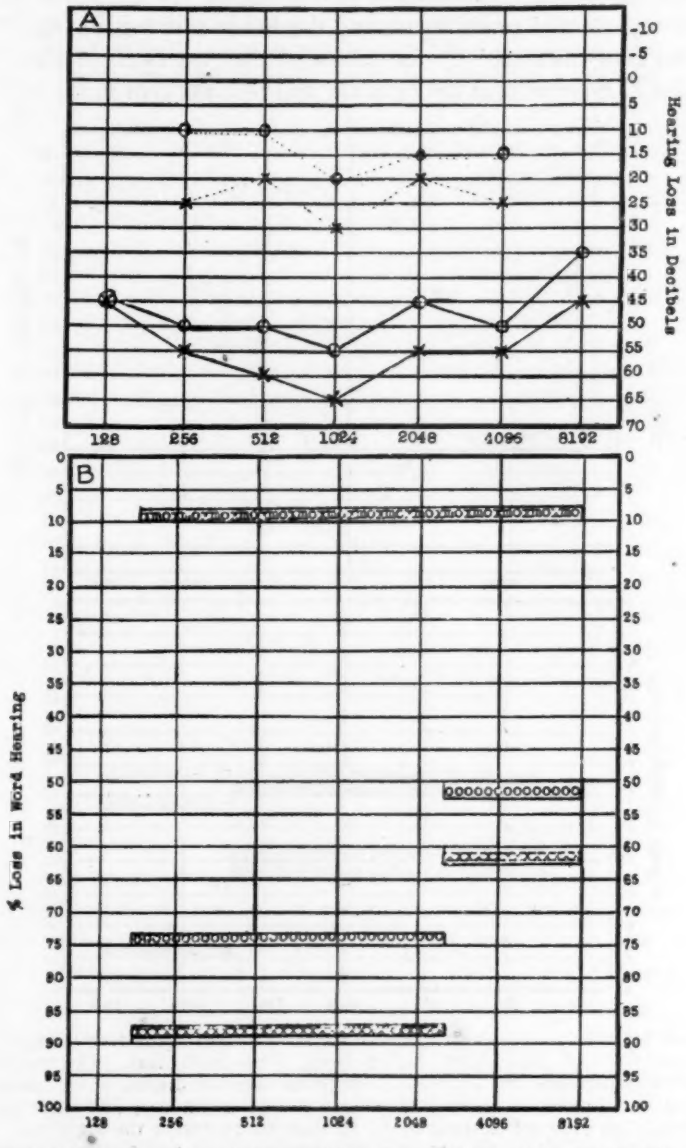

Chart 4 (case 4).—*A*, audiogram of D. Z., a patient with otosclerosis. Solid lines represent air conduction; dotted lines, bone conduction. Circles represent the right ear; crosses, the left ear. The percentages of disability according to the tables of the American Medical Association are: right ear, 58.2; left ear, 76.4. *B*, bargraph of word hearing of D. Z. Circles represent the right ear; crosses the left ear; *xmo*, either ear with microphone amplification.

word-hearing lists was less than 10 per cent loss. Amplification at 100 decibels was uncomfortable but not painful.

Chart 5 shows our findings in the case of a man, F. F., aged 70 years, whose hearing loss dates back about ten years. Otologic and nasopharyngoscopic examinations gave negative results. The loudness balance test showed recruitment, and the Rinne test was positive. Pure tone deafness calculated by the tables of the American Medical Association is 75.8 per cent in the right ear and 64.7 per cent in the left.

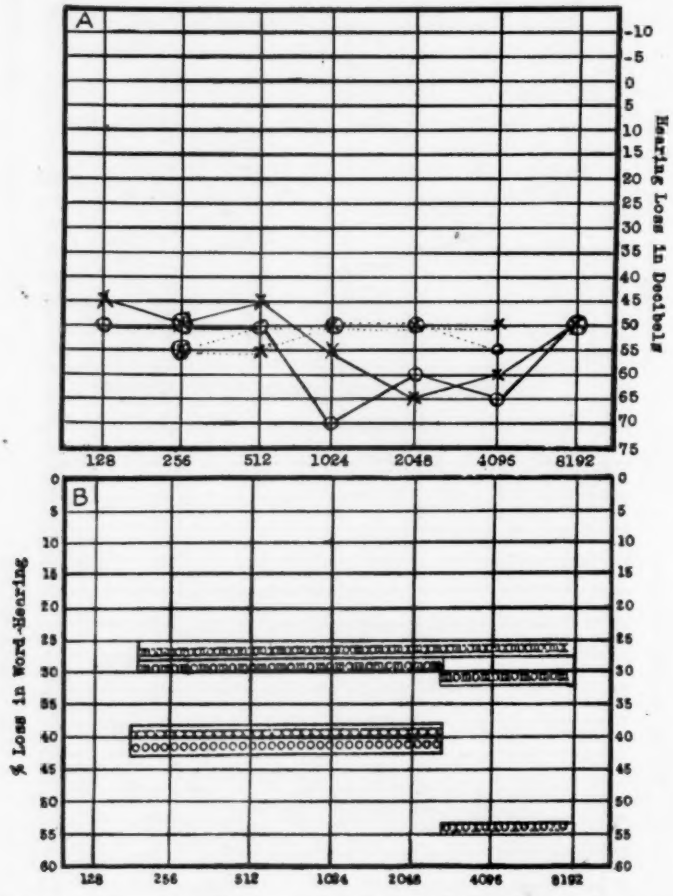

Chart 5 (case 5).—*A*, audiogram of F. F. who had perceptive deafness. Solid lines represent air conduction; dotted lines, bone conduction. Circles represent the right ear; crosses, the left ear. The percentages of disability according to the tables of the American Medical Association are: right ear, 75.8; left ear, 64.7. *B*, bargraph of word hearing of F. F. Circles represent the right ear; crosses the left ear; *oxox*, either ear; *momo;* the right ear with microphone amplification; *mxmx*, the left ear with microphone amplification.

The word-hearing loss was 40 per cent in the right ear and 38 per cent in the left for list 1, while for list 2 the score was 54 per cent loss for each ear.

For hearing with both ears, the patient facing the tester, whose lips were shielded, the loss was smaller. The score was 32 per cent for list 1 and 38 per cent for list 2.

With microphone amplification, improvement was reported at an intensity of 65 decibels and the most comfortable level was at 75 decibels, the loss being, at this point, 28 per cent for list 1 and 30 per cent for list 2 in the right ear, while in the left ear the loss was 26 per cent for both lists. At 80 decibels hearing was uncomfortable, and at 90 decibels it was painful.

SUMMARY AND CONCLUSIONS

In summarizing the high points of our processing of a case of deafness, the following studies seem essential:

1. History.
2. Otoscopy and rhinopharyngoscopy.
3. Nasopharyngoscopy, preferably direct.
4. Testing of bone conduction with tuning forks of 512, 1024 and 2048 double vibrations; a negative Rinne test is significant.
5. Pure tone audiometry; while it delineates only the threshold perception, it nevertheless affords a mental impression—a kind of pattern—of the basilar membrane as a whole.
6. Loudness balance test.
7. Word-hearing tests as outlined in this paper. Fletcher's [1] tables show that at a distance of 4 feet from speaker to listener, the difference between a soft voice and a strong voice is only 15 decibels. It follows, therefore, that the accuracy of word testing would be affected to a small extent only by an irregularity of the tester's voice—raising or lowering it slightly. The pattern of the response will still be distinctive enough for clinical purposes.
8. In the differential diagnosis of deafness, the patient's tolerance of, and benefit from, sound amplification are important points.
9. In regard to otosclerosis, the audiometer microphone offers an easy means of determining which patient is suitable for the fenestration operation. If microphone amplification greatly improves the hearing of speech, the chances are that a fenestra nov-ovalis will do likewise.

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1. Fletcher, H.: Speech and Hearing, New York, D. Van Nostrand Company, Inc., 1929, p. 204.

BETA HEMOLYTIC STREPTOCOCCUS PARASITISM IN INFECTIONS OF THE UPPER RESPIRATORY TRACT

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THE OBJECT of this study was to determine (1) the frequency of beta hemolytic streptococci in patients suffering from sore throat and (2) the response of these patients to local sulfathiazole therapy.

Though, generally speaking, these patients suffered from sore throat, they were readily divided into those who had acute exudative tonsillitis and pharyngitis, and those who had nonexudative infection of the tonsils and the pharynx, the latter condition usually ushering in a general infection of the upper respiratory tract.

The first group presents fairly characteristic signs and symptoms. The condition is characterized by the sudden onset of sore throat, which is constant and aggravated by swallowing. General malaise, headache, joint pains and usually backache are associated symptoms. The rise of body temperature ranges from 99 to 102 F. and is frequently accompanied by chills, rigors and sweating, though in milder attacks the latter symptoms may be absent. Examination of the throat reveals a swollen, hyperemic tonsil, the crypts of which contain much exudate. After twenty-four hours the condition spreads to the other tonsil, and in severe involvement the uvula may become edematous. In tonsillectomized patients in whom lymphoid tissue is present on the posterior and lateral walls of the pharynx, this tissue presents the same picture that is noted over the tonsillar area. Only lymphoid tissue seems involved, the mucous membrane apparently escaping. Dysphagia and angina often become severe enough to require opiates. The regional lymph glands become enlarged and painful, and the white blood cell count ranges from 12,000 to 20,000. In untreated patients the severe symptoms last from four to six days and then recede gradually. The temperature is usually normal by the fourth day, though some angina may persist for another forty-eight hours. In many cases with the same causation a

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milder symptomatic picture is presented, although the local findings appear severe.

The second group of patients frequently complains of angina as bitterly as the first group, but the general symptoms are invariably less severe. Locally, there is no exudate, and there are present only diffuse redness and swelling which, however, involve not only the lymphoid tissue but the mucous membrane in this area. Thus this condition differs from the first in lacking the selectivity for lymphoid tissue which is so noticeable in acute exudative tonsillitis and pharyngitis. It lasts, on an average, about forty-eight to seventy-two hours, after which it disappears entirely or extends into the nose or the lower respiratory tract. The white blood cell count usually shows only a modest rise over normal (i. e., an increase of 2,000 to 4,000), and infrequently an elevation of temperature is present. There may be some involvement of the regional lymph glands, but there are not the painfulness and enlargement of glands noted in the previous condition.

ROLE OF BETA HEMOLYTIC STREPTOCOCCUS IN ACUTE EXUDATIVE TONSILLITIS AND PHARYNGITIS

Felty and Hodges,[1] in 1923, were the first to suggest that acute tonsillitis is a specific entity caused by the hemolytic streptococcus, beta type. They based their contention on the fact that this organism was isolated in pure culture during the acute stage of the infection in 100 per cent of the cases. Though this finding has been verified by other investigators,[2] there still exists in the literature the opinion that acute exudative tonsillitis may be caused by all sorts of bacteria, such as pneumococci, influenza bacilli and staphylococci. Hopkins [3] reported that in a series of 99 patients suffering from tonsillitis 80 per cent harbored beta hemolytic streptococci in their tonsils. In an epidemic of 114 cases reported by Army investigators [4] these organisms were found in 83 per cent. Goldman and Kiesewetter [5] found them the principal invaders in acute tonsillitis, having isolated them from 31 of 64 patients.

1. Felty, A. R., and Hodges, A. B.: A Clinical Study of Acute Streptococcus Infection of the Pharyngeal Lymphoid Tissue (Acute Follicular Tonsillitis), Bull. Johns Hopkins Hosp. **34**:330-335 (Oct.) 1923.

2. Bloomfield, A. L.: Differentiation of the Common Varieties of Sore Throat, Stanford M. Bull. **1**:199-202 (Nov.) 1943.

3. Hopkins, W. A.: The Use of Sulphonamide Group of Drugs in the Treatment of Tonsillitis Due to the Beta-Hemolytic Streptococcus and in Acute Rheumatic Fever, Ann. Rheumat. Dis. **21**:233-246 (Dec.) 1941.

4. Pewters, J. T., and Bullock, L. T.: Epidemic of Acute Pharyngitis Due to Hemolytic Streptococci, Bull. U. S. Army M. Dept. **4**:579-582, (Nov.) 1945.

5. Goldman, J. L., and Kiesewetter, W. B.: Treatment of Acute Pharyngeal Infections by Insufflation of Sulfanilamide Powder, Arch. Otolaryng. **43**:99-109 (Feb.) 1946.

Bloomfield and Felty [6] reported that in sporadic beta hemolytic streptococcus infection of the throat parasitism is confined strictly to lymphoid tissue. They found this same condition to exist in carriers, also. Bloomfield found beta hemolytic streptococci in 35 to 40 per cent of normal people with tonsils and in only 5 to 8 per cent of tonsillectomized people. Investigators [7] reporting an epidemic of septic sore throat that occurred in an infantry regiment stated that a clear relationship was demonstrated between streptococcic parasitism and the presence or the absence of tonsils, since those with tonsils harbored the organisms longer, had confluent exudate and many organisms and tended to remain chronic carriers.

Hamburger,[8] in a recent report on the hemolytic streptococcus content of the saliva of 156 patients with scarlet fever and 76 patients with streptococcic tonsillitis and pharyngitis, found that tonsillectomy, though it did not protect against infection with beta hemolytic streptococci, did render the subject less likely to be a carrier of large numbers of organisms. McDonald and associates observed a much higher incidence of hemolytic streptococci in excised tonsils than on throat swabs of the same or a similar group of persons. The Commission on Acute Respiratory Diseases,[9] in a report concerning the epidemic of streptococcic throat at Fort Bragg, N. C., stated that subjects whose tonsils had been removed had less exudate and fewer streptococci, while those with tonsils had confluent exudate and tended to remain carriers.

In our series of cases, reported in this communication, there seemed to be a definite relationship between streptococcic parasitism and the presence of tonsils or hyperplastic pharyngeal lymphoid elements. Patients with large masses of lymphoid tissue in the pharynx or with large tonsils definitely had greater bacterial counts of all organisms and were the sicker patients. Patients without tonsils and with little pharyngeal tissue were not so sick and were only infrequently harborers of beta hemolytic streptococci. Moreover, their throats could be sterilized more rapidly.

Lymphoid tissue seems to supply the medium par excellence for growth of beta hemolytic streptococci, but the fact that these organisms have been recovered from the tonsils or from pharyngeal lymphoid

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6. Bloomfield, A. L., and Felty, A. R.: Definition of Hemolytic Streptococcus Parasitism in the Upper Air Passages of Healthy People, Arch. Int. Med. **32**:386-400 (Sept.) 1923.

7. Epidemic of Septic Sore Throat Caused by Hemolytic Streptococci of Group A, Type 5, Bull. U. S. Army M. Dept. **4**:497-498 (Nov.) 1945.

8. Hamburger, M., Jr.: Studies on the Transmission of Hemolytic Streptococcus Infections: Beta Hemolytic Streptococci in the Saliva of Persons with Positive Throat Cultures, J. Infect. Dis. **75**:71-78 (July-Aug.) 1944.

9. Endemic Exudative Pharyngitis and Tonsillitis, Commission on Acute Respiratory Diseases, J. A. M. A. **125**:1163-1169 (Aug. 26) 1944.

tissue does not necessarily prove them to be the primary etiologic agent of disease. Beta hemolytic streptococci may be found in the throats of healthy persons. Hare [10] found that on the average about 7 per cent of the normal population have these organisms in their throats. Hamburger and associates [11] found that among 404 normal men studied 19.1 per cent were throat carriers of beta hemolytic streptococci. Among normal young adults, chiefly medical students, Rhoads and Afremow [12] found 20 per cent harboring the organisms, but in no instance was a normal-appearing mucous membrane found to contain them in large numbers.

Lancefield [13] demonstrated the grouping of streptococci on the basis of a precipitin reaction. She has shown that almost all human infections are caused by her group A, while groups B to K are responsible for many types of animal infections and are also frequently present as normal inhabitants of the human nose and throat. Griffith [14] further classified group A streptococci into thirty subdivisions or types on the basis of agglutination tests. Though the identification of the particular type does not lend itself as an adjunct to the treatment of disease caused by these organisms, this knowledge of type specificity, as Keefer and associates [15] have pointed out, has greatly clarified the old controversy as to whether these organisms are involved in particular diseases. It has been demonstrated, for example, that scarlet fever, tonsillitis, mastoiditis, erysipelas and puerperal morbidity may all be caused by the same type of beta hemolytic streptococci.

One procedure available for the corroboration of a beta hemolytic streptococcus infection includes that of demonstrating antibodies during convalescence. This, however, is too complicated for the ordinary office laboratory. Other procedures include determining the presence of an increase in the titer of antistreptolysin or antifibrinolysin. Though

10. Hare, R.: Memorandum on Possible Methods for Prevention of Rheumatic Manifestations in the Armed Forces (Relation to Streptococcic Sore Throat and Droplet Infection), Canad. M. A. J. **48**:116-121 (Feb.) 1943.

11. Hamburger, M.; Green, M. J. and Hamburger, V. G.: The Problem of the "Dangerous" Carrier of Hemolytic Streptococci: I. Number of Hemolytic Streptococci Expelled by Carriers with Positive and Negative Nose Cultures, J. Infect. Dis. **77**: 68-82 (July-Aug.) 1945.

12. Rhoads, P. S., and Afremow, M. E.: Streptococcic Infections of the Nose and Throat in Young Adults: Incidence, Epidemiology and Clinical Features, Arch. Int. Med. **71**:443-453 (April) 1943.

13. Lancefield, R. C.: Serological Differentiation of Human and Other Groups of Hemolytic Streptococci, J. Exper. Med. **57**:571-595 (April) 1933.

14. Griffith, F.: Serological Classification of Streptococcus Pyogenes, J. Hyg. **34**:542-584 (Dec.) 1934.

15. Keefer, C. S.; Rantz, L. A.; Shuman H. H., and Rammelkamp, C. H.: Distribution of Specific Types of Hemolytic Streptococci in Eight Hundred and Nineteen Cases of Infection, Arch. Int. Med. **69**:952-973 (June) 1942.

the antistreptolysin test is more highly specific, the antifibrinolysin test [16] is simple enough for routine clinical use. Normally, hemolytic streptococci will rapidly dissolve a blood clot. However, after patients have been infected with these organisms, the antifibrinolysin present in the blood prevents rapid liquefaction of the clot. The test gives a positive reaction in about 80 per cent of cases of beta hemolytic streptococcus infection.

METHODS

Cultures were obtained for qualitative study by swabbing the infected area and transferring the material to brain broth. This was incubated for one hour and then was transferred to poured sheep's blood agar plates. Cultures were obtained for quantitative study by having the patient gargle 10 cc. of brain broth vigorously for a full minute and then making serial dilutions of this material for transfer to poured sheep's blood agar plates; 1 cc. of the rinsings was transferred to 9 cc. of a sterile 0.85 per cent solution of sodium chloride, and from this suspension various dilutions were made. In the follow-up examination blood agar medium was used containing 5 mg. of para-aminobenzoic acid per liter, in order to eliminate any bacteriostatic effect of the sulfonamide drug used for topical treatment, which might have been carried over in the rinsing. Plates were made in duplicate for aerobic and anaerobic cultures. Brewer's plates were used for anaerobiosis. The patients were examined every twenty-four hours during the stage of acute illness, and at the end of thirty days their blood was tested for increase of antifibrinolysin content.

RESULTS

Throat culture studies were made of 400 patients suffering from sore throat. All had the sporadic types of sore throat seen in ordinary office practice. No epidemic conditions were included. In 64 patients unilateral or bilateral exudative tonsillitis or pharyngitis was present without any particular involvement of the pharyngeal mucosa except that covering lymphoid tissue. In 336 patients the soreness was due to a diffuse nonexudative inflammation of the pharyngeal lymphoid tissue and mucous membrane. The frequency with which beta hemolytic streptococci were isolated in the 64 cases of exudative tonsillitis and pharyngitis was 48, or 75 per cent, while the frequency in the 336 cases of nonexudative tonsillitis and pharyngitis was 24, or about 7 per cent.

An increase of antifibrinolysin titer was demonstrated in 38 of the 48 cases of exudative tonsillitis in which beta hemolytic streptococci had previously been isolated, i. e., in about 79 per cent. Of the 24 cases of nonexudative tonsillitis and pharyngitis in which beta hemolytic streptococci were harbored, an increase of antifibrinolysin titer was demonstrated in only 2, i. e., in 8 per cent.

It would seem from this evidence that the beta hemolytic streptococcus, though not commonly an important etiologic factor in the ordinary sore throat, is specifically the cause of exudative tonsillitis and

16. Tillett, W. S., and Garner, R. L.: The Fibrinolytic Activity of Hemolytic Streptococci, J. Exper. Med. **58**:485-502 (Oct.) 1933.

pharyngitis. I am inclined to concur with Bloomfield,[2] who summarized the situation as follows:

> . . . sore throats commonly encountered fall for the most part into two . . . groups. The first is featured by inflammation of the tonsils or other bits of nasopharyngeal lymphadenoid tissue with local exudate, swollen tender lymph nodes, and leucocytosis. These infections are caused by hemolytic streptococci and make up the "tonsillitis–scarlet-fever–septic-sore-throat syndrome." The second group are often obviously part and parcel of an acute coryza or influenza. At any rate there is either little deviation from normal in the appearance of the throat, or there is a slight diffuse redness. There is never local swelling of the tonsils with patchy exudate and there are usually no tender glands at the angles of the jaw. Leucopenia or absence of leucocytosis is the rule. This group is caused by viruses, and if hemolytic streptococci are recovered they are probably not the cause of the sore throat but have overflowed from a local focus in which they are "carried."

TREATMENT

That the sulfonamide drugs are bacteriostatic against streptococci and staphylococci has been amply demonstrated. It might be expected

TABLE 1.—*Summary of Results*

	Percentage of Patients Showing Beta Hemolytic Streptococcus Parasitism	Percentage Showing Increase of Antifibrinolysin in the Blood	Percentage Showing Increase of White Blood Cells to 5,000 or More Over Normal
Exudative sore throat.....	82	70	85
Nonexudative sore throat.....	7	8	9

that the ingestion of these drugs would be as effective against beta hemolytic streptococci causing sore throat as it is against streptococci elsewhere in the body. However, there has been some controversy as to whether the sulfonamide compounds are effective in cases of tonsillitis and pharyngitis. While many investigators have reported great success in treating sore throats due to beta hemolytic streptococci with sulfonamide drugs, a number of others, among them Rhoads and Afremow,[17] Clodfelter [18] and Hamburger,[8] have expressed the opinion that the results obtained with these drugs are no better than those derived from the use of the salicylates or codeine or from the routinely used gargles. Rhoads complained that the favorable results cited in the literature are inconclusive because of the failure to provide adequate controls. In a later paper, however, he reported that he had terminated the carrier state in 9 persons by daily spraying of the throat

17. Rhoads, P. S., and Afremow, M. L.: Sulfanilamide in Treatment of Sore Throat Due to Hemolytic Streptococci, with Controls, J. A. M. A. **114**:942-943 (March 16) 1940.

18. Clodfelter, H. M.: Treatment of Severe Acute Tonsillitis With and Without Sulfonamides, Ohio State M. J. **41**:819-820 (Sept.) 1945.

and the nose with a 2.5 per cent solution of sodium sulfathiazole or sodium sulfadiazine. Of course, many of the reported negative results are also poorly controlled, for at best the value of statistical analysis of such results is questionable, since a comparison of pharyngeal and tonsillar lesions is difficult, and the presence of beta hemolytic streptococci of itself may not indicate how great a factor these organisms are in the causation of the disease. Beta hemolytic streptococci are frequently isolated from tonsillar crypts during apparently normal states. Bloomfield [2] has pointed out "that hemolytic streptococci obtained from the throats of healthy people remain as the dormant legacy of a previous acute infection of the lymphadenoid tissue in the throat."

Some literature has accumulated concerning the effectiveness of sulfonamide drugs used locally in the throat. Freis [19] has reported good results obtained with a sulfonamide compound which was applied frequently in dry powder form to the infected area, as well as with a candy wafer containing a mixture of sulfonamide drugs, though the efficacy of this method of treatment must of necessity be limited because of the rapid disappearance of the drug, due to the action of the saliva. However, he reports that with this dosage the blood levels were never found to be above 1 mg. per hundred cubic centimeters and usually were too low to be read by standard methods.

Pfeiffer and Holland [20] found that the chewing gum wafer in which chicle was the vehicle of sulfathiazole consistently gave the highest salivary levels, which were maintained for ninety minutes. This is in practical agreement with similar studies made by Fox and associates.[21] Garson [22] used a lozenge containing 0.065 Gm. of sulfanilamide in chicle and chocolate in the treatment of acute streptococcic tonsillitis. In 86 cases he noted immediate relief of pain in the throat. The patients thus treated averaged 2.6 days of hospitalization as against 5.1 days for the 41 controls.

Sulfathiazole is not as toxic as the other sulfonamide drugs and exerts an antibacterial effect on pneumococci and staphylococci as well as on beta hemolytic streptococci. According to Pfeiffer and Holland,[20] its bacteriostatic potency is twice that of other sulfonamide compounds. There is some evidence that alpha and gamma streptococci are also

19. Freis, E. D.: Treatment of Tonsillitis with Small Doses of Sulfonamides, J. A. M. A. **126**:93-94 (Sept. 9) 1944.

20. Pfeiffer, C. C., and Holland, H. L.: Salivary Sulfonamide Levels After Chewing Paraffin and Chicle Vehicles, U. S. Nav. M. Bull. **44**:695-699 (April) 1945.

21. Fox, N.; Kesel, R. G.; Nery, E. R., and Herbine, R. H.: Effect of Sulfathiazole in Chewing Gum in Certain Oropharyngeal Infections, Arch. Otolaryng. **41**:278-283 (April) 1945.

22. Garson, P.: Local Oral Medication with Sulphanilamide in Lozenge Form, Brit. M. J. **2**:452-454 (Oct. 9) 1943.

affected when large enough doses of sulfathiazole are used. That high salivary concentrations of sulfathiazole can be maintained for long periods and be safely tolerated has been demonstrated by Fox and co-workers,[21] who have shown that adults chewing two tablets of gum, containing a total of 0.5 Gm. of sulfathiazole, for one-half hour of every hour over a period of twelve hours show only a trace of sulfathiazole in the blood at the end of this period, a large part of the drug being retained in the chewing gum vehicle.

Fleming [23] incorporated sulfapyridine into a chewing gum vehicle for the treatment of a group of medical students and nurses whose throats were infected with hemolytic streptococci. Though he found it difficult to assess the value of the therapy accurately, he felt that on the whole the results were good and that this type of therapy offered some hope that the sulfonamide compound could be applied more or less continuously to an infected area and hence should be the choice of treatment for tonsillitis and pharyngitis. Rosenthal [24] reported excellent results obtained in cases of streptococcic pharyngitis and tonsillitis through the use of a chewing wafer containing sulfathiazole. He found that resolution of the inflammatory process usually occurred in two or three days.

The local antibiotic effect of the sulfonamide drugs on oral and pharyngeal mucous membranes depends on the length of time that the drug is kept in contact with the infected surface and on the ability of the drug to diffuse into and penetrate the deeper layers of tissue harboring the bacteria.

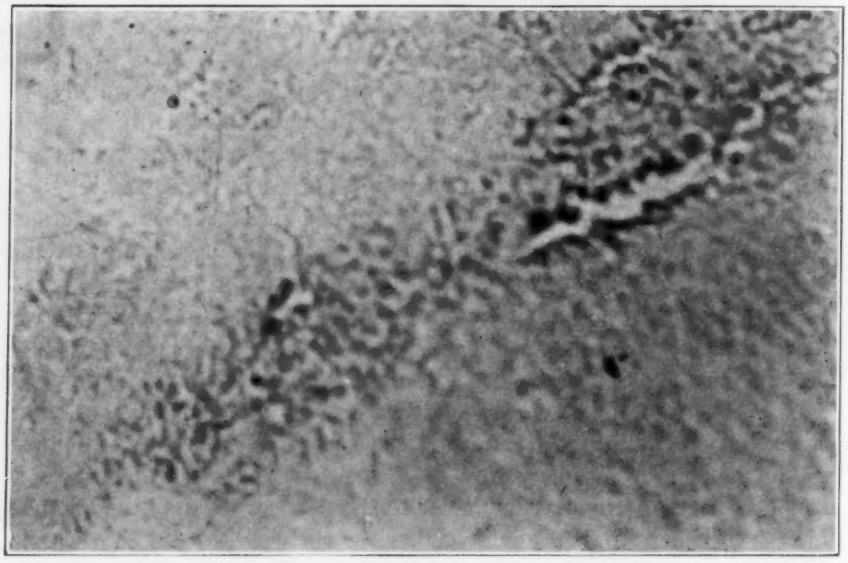
McKee and associates [25] developed a method of staining sulfathiazole deposits in tissue. The reaction depends on the formation of a characteristic precipitate in sections treated with a solution containing p-dimethylaminobenzaldehyde, i. e., "Ehrlich's reagent," which gives a bright orange or lemon yellow color to the deposit. I used this method in an experiment to determine whether the chewing of sulfathiazole gum resulted in tonsillar absorption of the drug. The patient was given a chewing gum tablet containing 0.25 Gm. of sulfathiazole, which was to be chewed continuously for one hour previous to removal of the tonsils. The operation was done with the patient under general anesthesia, because procaine and related local anesthetics produce a similar reaction. The figure shows a section taken through a tonsillar crypt, demonstrating a deposit of sulfathiazole in the mucous membrane of this area.

23. Fleming, A.: The Prevention of Pyogenic Infections of the Nose and Throat, J. Laryng. & Otol. **58**:296-304 (July) 1943.

24. Rosenthal, H. H.: Simple Treatment of Throat Infections by Chewing Penicillin and Sulfathiazole Lozenges, U. S. Nav. M. Bull. **45**:75-76 (July) 1945.

25. McKee, G. M.; Hermann, F.; Baer, R. L., and Sulzberger, M. B.: A Histochemical Method for Demonstrating the Presence of Sulfonamides in the Tissues, J. Lab. & Clin. Med. **28**:1642-1648 (Oct.) 1943.

Continuous systemic use of sulfonamide drugs, as is commonly attempted for purposes of prophylaxis, might lead to the development of sulfonamide-resistant strains of beta hemolytic streptococci. Damrosh,[26] as well as the United States Navy Department, in its Bumed News letter of April 13, 1945,[27] reported the appearance of sulfonamide-resistant strains. In the latter report, the investigators stated that there had been a marked reduction of streptococcic diseases in northern camps but that Lancefield types 17, 19 and 3 had appeared, which have consistently been found to be sulfonamide resistant. Whether strains previously susceptible become resistant is still a matter of controversy and is being studied by epidemiologists. Holbrook,[28] reporting on the Army's program of sulfonamide prophylaxis, stated that no



Sulfathiazole deposited in the mucous membrane of a tonsillar crypt during the chewing of a gum tablet containing 0.25 Gm. of the compound.

evidence of the development of bacterial resistance was observed in approximately 10,000 troops, who responded as well to a second course

26. Damrosh, D. S.: Sulphonamide Resistant Streptococci, J. A. M. A. **130**:124-128 (Jan. 19) 1946.

27. Sulfonamide Resistance and Sulfonamide Prophylaxis, Bumed. News Letter (April 13) 1945. Sulfadiazine Resistant Strains of Beta Hemolytic Streptococci: Appearance During the Course of Sulfadiazine Prophylaxis at a Large Naval Training Center, Epidemiology Unit Number 22, J. A. M. A. **129**:921-927 (Dec. 1) 1945.

28. Holbrook, W. P.: The Army Air Forces Rheumatic Fever Control Program for the Control of Streptococcal Infections, Publication 284, United States Navy Department, Bureau of Medicine and Surgery, 1944.

of chemoprophylaxis as to the first. Tainter [29] has commented that, so far as local methods of application of sulfonamide compounds (in the form of nose drops, salves, etc., containing them) are concerned, "there would seem to be little evidence that the very minimal and limited exposure of the body to sulfa compounds under these methods of application could alter, in any significant way, the reactivity of invasive organisms."

In the procedure of treatment on which the present study was made, each of the two groups of patients classified on the basis of having exudative tonsillitis and nonexudative infections of the throat, respectively, was divided into two numerically equal subgroups. With 32 of the patients who had exudative tonsillitis, treatment consisted of having each chew a gum tablet containing 0.25 Gm. of sulfathiazole for one hour, repeating every other hour. The gum was chewed only during waking hours. Except for rest in bed, no other local treatment was used. In the patients under this treatment any improvement noted must be credited to the local, rather than to the systemic, effect of the drug, since previous experiments have shown that under similar conditions only a trace of sulfathiazole is found in the blood at the end of twelve hours. No other treatment was given except for relief of pain, for which a capsule was taken twice daily, containing ½ grain (32 mg.) of codeine sulfate, 3 grains (0.19 Gm.) of acetophenetidin and ½ grain (32 mg.) of caffeine. The second subgroup of 32 patients with exudative tonsillitis was given a gargle consisting of warm saline solution. A glass of this solution was gargled every two hours; in addition, these patients were placed on daily doses of 40 grains (2.59 Gm.) each of sodium salicylate and sodium bicarbonate. Patients with fever were put to bed. The treatment instituted in the two numerically equal subgroups of the total of 336 patients with nonexudative tonsillitis was similar to that employed in the two subgroups of patients with exudative tonsillitis.

The average duration of clinical illness in the cases of exudative tonsillitis in which beta hemolytic streptococci were found was three days with sulfathiazole gum therapy, while in those in which the salicylates were used the average duration was five days. In the cases of nonexudative tonsillitis in which sulfathiazole gum was used, the average length of illness was three days, and in those in which salicylates were used, it was also three days.

In 26 of the 32 cases of exudative tonsillitis with sulfathiazole gum therapy, the carrier period averaged twenty days. In the remaining 6 cases of the group the throat cultures continued to be positive for beta hemolytic streptococci over a period of three months. In the

29. Tainter, M. L.: A Summary of the Problems of Sulfa and Penicillin Fastness, New York State J. Med. **45**:2509-2514 (Dec. 1) 1945.

second subgroup of 32 cases of exudative tonsillitis with salicylate therapy, the average carrier period was twenty-two days. Here the carrier state persisted in 8 cases.

I believe that sulfathiazole used locally and continuously, as is practicable when the drug is incorporated in a vehicle of chewing gum, appreciably shortens the period of disability encountered in acute tonsillitis and pharyngitis caused by beta hemolytic streptococci. In only a single case was there any local or general manifestation of sensitization to sulfathiazole.

TABLE 2.—*Average Duration of Illness According to Therapy*

Cases of Exudative Tonsillitis and Pharyngitis		Cases of Nonexudative Tonsillitis and Pharyngitis	
Sulfathiazole-Gum Therapy	Salicylate Therapy	Sulfathiazole-Gum Therapy	Salicylate Therapy
3 days	5 days	3 days	3 days

SUMMARY AND CONCLUSIONS

A 75 per cent incidence of beta hemolytic streptococcus parasitism was found in the throats of persons suffering from acute exudative tonsillitis and pharyngitis.

The presence of this organism and a later increase in antifibrinolysin stamp it as the etiologic agent.

Patients suffering from nonexudative pharyngitis and tonsillitis do not harbor beta hemolytic streptococci in any proportion greater than that noted in the normal carrier population.

The chewing of gum containing sulfathiazole seems definitely to shorten the active symptoms of persons suffering from exudative tonsillitis and pharyngitis.

The chewing of a tablet of gum containing 0.25 Gm. of sulfathiazole for one hour results in the deposition, in the crypts of the tonsils, of a discernible amount of the sulfonamide compound.

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SYNDROME OF AVELLIS

A Review of the Literature and Report of One Case

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SINCE George Avellis,[1] a German laryngologist, first published his series of 10 cases of this syndrome in 1891, less than 30 cases have been reported in the available literature.[2]

The syndrome of Avellis comprises a hemiparalysis of the larynx and soft palate on the same side, and, according to Jackson and Jackson,[3] "there may be loss of pain and temperature sense on the opposite side, including the extremities, trunk and neck." This complex syndrome frequently results from a pathologic condition at the jugular foramen, though in some of the cases reported it was supposed to be of bulbar origin. Since the vagus nerve is closely associated with its neighboring cranial nerves at this level, numerous combinations and modifications are possible and have been described.[4] It is not the object

From the Department of Otolaryngology of the South Baltimore General Hospital and the University of Maryland School of Medicine.

1. Avellis, G.: Klinische Beiträge zur halbseitigen Kehlkopflahmung, Berl. klin. **40**:1-26, 1891.

2. (*a*) Imperatori, C. J.: Syndrome of Avellis, Arch. Otolaryng. **1**:277-282 (March) 1925. (*b*) Lovesey, B. E.: Syndrome of Avellis, Ann. Otol., Rhin. & Laryng. **53**:174-179, 1944. (*c*) Croizier and Aloin: Sur deux cas de syndrome d'Avellis, Bull. Soc. méd. d.hôp. de Lyon **10**:404-409, 1912. (*d*) Deferine, J., and Quercy, H.: Un cas de syndrome d'Avellis avec troubles de l'appareil vestibulaire et hémianesthésie alterne dissociée, Rev. neurol. **23**:835-838, 1912. (*e*) Gaudier, H., and Minet, J.: Syndrome d'Avellis avec paralysie faciale et hémiparésie homolatérales, Écho méd. du Nord **17**:536-538, 1913. (*f*) New, G. B.: Laryngeal Paralysis Associated with the Jugular Foramen Syndrome and Other Syndromes, Am. J. M. Sc. **165**:727-737, 1923. (*g*) Collet, F. J.: Des paralysies laryngées, Province méd., Lyon **10**:253-258, 1896. (*h*) diLauro, E.: Un caso di sindrome di Avellis pura, Gazz. internaz. med. chir. **38**:753, 1930. (*i*) Pinson, L.: Un syndrome d'Avellis, Rev. de laryng. **57**:513-516, 1936. (*j*) Poli, C.: Sulla sindrome di Avellis, Arch. ital. di otol. **17**:215-224, 1905-1906. (*k*) Portmann, G.; Despons, J., and Pinson, L.: Sur un cas de syndrome d'Avellis, Rev. d'oto-neuro-opht. **15**:265, 1937. (*l*) Collet, F. J.: Paralysies pharyngo-laryngées, Ann. d. mal. de l'oreille du larynx **48**:619-633, 1929.

3. Jackson, C., and Jackson, C. L.: Diseases of the Nose, Throat and Ear, Philadelphia, W. B. Saunders Company, 1945.

4. Lederer, F. L.: Diseases of the Ear, Nose and Throat, Philadelphia, F. A. Davis Company, 1945.

of this paper to discuss in detail the related syndromes or modifications but merely to review the reported cases of the syndrome of Avellis.

Avellis,[1] in reviewing 150 cases of recurrent laryngeal paralysis, described 10 cases in which there was hemilateral paralysis of the larynx associated with paralysis of one-half the soft palate on the same side. In this original series of cases of the syndrome described by Avellis, the left side was involved in 8 and the right vocal cord and soft palate in 2. In 4 of the cases no cause could be found clinically, and none of the 10 cases came to autopsy. In 1 case the syndrome was thought to have followed cerebral apoplexy; in another, a thoracic tumor was suspected. In 1 case it was believed to be of bulbar origin; in 1 case syphilis of the central nervous system was present and thought to be the cause; an aortic aneurysm was believed to be the cause in another; and in 1 case an enlarged thyroid gland and cardiac murmur were the only findings. In every case studied by Avellis there was noticeable difficulty in swallowing. Though no such observation was made by him at the time, it is now believed that there may well have been an associated hemiparalysis of the esophagus in all of these cases.

Poli,[2] in 1905, reviewed the existing literature and found 63 cases of hemiparalysis of the larynx and reported 8 additional cases. In an analysis of these 71 cases he considered that 18 of them represented the pure syndrome of Avellis. In none of these 18 cases was the cause established by autopsy. Poli observed that 12 of the patients were men and 6 women, and he corroborated the previous observation of Avellis that the paralysis of the soft palate occurred either concomitantly with the paralysis of the vocal cord or followed it but never preceded it.

Various authors subsequently described similar cases with involvement of additional cranial nerves. Vernet,[5] in 1918, was one of the first to review the various syndromes associated with laryngeal paralysis and to present a comprehensive classification of them. Since that time still others have been added, until today the picture is rather confused. For clarification, a tabular representation is presented from Lederer[4]:

	Paralysis of:				
Syndrome	IX	X		XI	XII
	Taste	Vocal Cord	and Palate	Shoulder	Tongue
Collet and Sicard	+	+	+	+	+
Hughlings Jackson		+	+	+	+
Vernet	+	+	+	+	
Schmidt		+	+	+	
Avellis		+	+		
Tapia		+			+
Villaret	+	+	+		+

5. Vernet, M.: The Classification of Syndromes of Associated Laryngeal Paralyses, J. Laryng. & Otol. **33**:354-365, 1918.

Lederer made a plea for a simplified nomenclature based on the anatomic location of the nerve lesions and suggested the following classification:

Syndrome	Paralysis in Domain of:	Vagus Lesion
Bulbar	IX, X, XI, XII (V, VI, VII, VIII)	High vagus paralysis
Jugular foramen	IX, X, XI, XII and sympathetic	High vagus paralysis
Parapharyngeal space	IX, X, XII (VII) and sympathetic	Deep vagus paralysis
Arch of aorta	X, phrenic, sympathetic	Recurrent laryngeal nerve or deep vagus paralysis

To fully appreciate the syndrome of Avellis, one should briefly review the anatomy: The vagus nerve as it emerges from the jugular foramen is accompanied by and contained in the same sheath of dura mater with the accessory nerve, and only a fibrous septum separates them from the glossopharyngeal nerve anteriorly. The accessory nerve, on making its exit from the jugular foramen, separates into a cranial and a spinal portion. The vagus nerve, after its exit from the jugular foramen, is joined by the cranial portion of the accessory nerve and enlarges into a ganglioform swelling called the ganglion nodosum. Through this the fibers of the cranial portion of the accessory nerve pass without interruption and are distributed chiefly to the pharyngeal and superior laryngeal branches of the vagus nerve. Thus the pharyngeal branch of the vagus nerve consists principally of filaments of the cranial portion of the accessory nerve. Its branches are joined by branches from the glossopharyngeal, sympathetic and external laryngeal nerves to form the pharyngeal plexus. The plexus supplies the muscles of the pharynx and soft palate except the tensor veli palatini, which is innervated by a branch of the trigeminal nerve.

The external branch of the superior laryngeal branch of the vagus nerve supplies the cricothyroid muscle and gives off branches to the pharyngeal plexus and to the inferior constrictor muscle of the pharynx.[6]

From the foregoing description it can be appreciated that a lesion of the vagus nerve just after this emerges from the jugular foramen can give rise to a syndrome such as that described by Avellis. It is likewise now apparent that in this syndrome the lesion must be at or near the jugular foramen. In those cases in which the patient exhibits disturbances of pain and thermal sensibility on the opposite side, there is a lesion in the brain affecting the vagal fibers and the lateral (posterior) spinothalamic tract, and those cases cannot be considered as representing the syndrome of Avellis.

6. Gray, H.: Anatomy of the Human Body, ed. 23, edited by W. H. Lewis, Philadelphia, Lea & Febiger, 1936.

The lesions which may produce the syndrome can be classified etiologically as:

(*a*) Vascular—an aneurysm exerting pressure, rupture of a vessel, thrombosis of the bulb, etc.

(*b*) Inflammatory—complicated mastoiditis, cervical adenitis, cellulitis, etc.

(*c*) Neoplastic—primary or metastatic tumors

(*d*) Traumatic—fracture of the skull, direct injury (as in gunshot and stab wounds), etc.

(*e*) Toxic—effects of alcohol, poisons, etc.

By far the most important causes are the inflammatory and vascular lesions; however, cerebrospinal syphilis, tuberculoma and syringomyelia have also been suggested. No case report could be found in which mastoiditis was the etiologic factor.

The prognosis depends to a large extent on the cause. As with all nerve lesions, whatever the cause, the prognosis will depend on whether the nerve is permanently damaged. If the lesion is early or of a temporary character (as in pressure from edema of inflammatory reactions) the prognosis is usually good, but if such a lesion is allowed to continue over a period of time, irreversible damage of the neurons results.

The treatment should be directed toward the primary cause of the lesion, when this is possible. The most amenable lesions are those of inflammatory origin. Certain neoplastic and vascular lesions may be eradicated by surgical procedure. Lesions of toxic origin should be treated as other systemic toxemias. The treatment of traumatic injuries of the nerves should be conservative and symptomatic unless it is possible to relieve pressure surgically.

Large doses of thiamine hydrochloride may prove valuable in protecting the myelin sheath, particularly in lesions which are of a temporary nature. Strychnine, nux vomica and other so-called nerve stimulants have been used. Stimulation of the laryngeal muscles with the faradic current has been recommended.

Operations directed to the laryngeal element of the syndrome when the primary cause of the nerve lesion is not curable are advocated only in cases in which obstruction occurs.

The following case is reported because of its unusual etiologic aspects and the apparent rarity of case reports on the subject matter under discussion.

REPORT OF CASE

R. S., a 33 year old Negro man, was brought to the accident room by the police on Dec. 8, 1945. He had been found lying unconscious on the street. On admission to the medical service, the patient was semicomatose, and no history could be obtained. The history obtained in his convalescent period, a month later,

revealed that he had a severe cold, earache and sore throat of two weeks' duration prior to the onset of the illness. The past history and the family history were noncontributory.

On admission the patient was extremely toxic and semicomatose, with a temperature of 100 F. rectally, a pulse rate of 100 and a respiratory rate of 28. The blood pressure was 130 systolic and 90 diastolic. The eyes reacted to light and accommodation, but ocular motility could not be tested. The eyelids and the conjunctiva appeared normal. The nose revealed adequate breathing space, with the septum in the midline and intact. There was some purulent discharge on both sides. The mouth and throat showed the teeth in poor repair, the mucous membranes pale and the postpharynx slightly injected. The canal and the drum of the left ear were normal. The canal of the right ear contained a tenacious purulent exudate, and the drum membrane showed a large central perforation. The remainder of the examination showed nothing abnormal except for the reflexes, which were sluggish but physiologic. The impression at this time was that he had syphilis of the central nervous system or meningitis, with chronic suppurative otitis media on the right side.

Urinalysis on admission gave negative results. The blood showed 72 per cent hemoglobin, 4,010,000 red blood cells per cubic millimeter and 25,200 white cells, of which 89 per cent were polymorphonuclears and 11 per cent lymphocytes. The Kahn test of the blood showed a 4 plus reaction. The blood sugar was 96 mg. and the nonprotein nitrogen was 168 mg. per hundred cubic centimeters Numerous other laboratory studies were carried out and gave results that were within normal limits.

The patient was given 20,000 units of penicillin intramuscularly every three hours, but his condition continued unimproved. On December 13 a spinal tap was done; a pressure of 200 mm. of water was noted. The fluid was clear and contained 78 white cells per cubic millimeter; subsequent culture showed no growth. Irrigations of the right ear were begun, followed by instillation of sulfadiazine, 2.5 per cent in ethanolamine solution (Pickrell),[7] every three hours. The patient continued extremely ill, and the rectal temperature ranged from 104 to 100 F., never reaching normal.

Otolaryngologic consultation was requested on December 20. A necessarily incomplete examination revealed at this time definite acute mastoiditis on the right side with meningeal involvement. Roentgen films confirmed this diagnosis. Mastoidectomy was advised and immediately performed with the patient under sodium pentothal anesthesia. A copious quantity of frank pus was encountered on removal of the cortex, and the cells were almost completely broken down by necrosis. The lateral sinus was uncovered for a considerable distance. It appeared somewhat dark but otherwise normal. Under aseptic technic, the sinus was aspirated by needle puncture, and free flowing blood was obtained. Careful exploration failed to reveal any gross defect in the tegmen tympani, but the bone was so necrotic that it was taken down and the dura exposed over a considerable area. The dura was congested, bled readily and appeared under tension. The wound was packed lightly with iodoform gauze tape, and no attempt was made to close the incision. A wide myringotomy was done.

Postoperatively the patient was given 20,000 units of penicillin intramuscularly every three hours, and after regaining consciousness he received 1.0 Gm. of sulfa-

7. This is sulfadiazine 2.5 per cent in an aqueous medium containing triethanolamine solution U.S.P. 8 per cent W/V, with sodium benzoate 0.2 per cent as a preservative, marketed by Lederle Laboratories, Inc.

diazine orally every four hours. Fluids containing thiamine hydrochloride, ascorbic acid and amino acids were given intravenously twice daily, along with several transfusions of whole blood during the following days. Active antisyphilitic therapy was not deemed advisable at this time, because of his critical condition.

Three days after operation the patient became rational, the temperature was 100 F. rectally, and the general clinical picture was much improved. One week after operation the patient's temperature was normal, he was sitting up in bed, and his only complaint was hoarseness and difficulty in swallowing, which he stated were not present prior to his admission.

Examination of the larynx revealed abductor paralysis of the vocal cord and flaccidity of the soft palate on the right side. Twelve days postoperatively the temperature became normal and thereafter remained so. Two weeks postoperatively the mastoid wound was clean and granulating well, the tympanic membrane was healed and the middle ear was dry. His hoarseness remained but seemed improved on discharge. His pharyngeal palsy had cleared by this time.

He returned to the outpatient clinic twice a week, and by the first of February 1946 his hoarseness had disappeared, the larynx showed normal function, the mastoid wound had completely healed and the drum was intact. Since that date, the patient has failed to return, and contact with him has been lost.

SUMMARY

A review of the syndrome of Avellis is presented with especial reference to the original report published by Avellis.

One case is reported because of its apparently unusual causation; i. e., it was secondary to acute mastoiditis. There was complete recovery in this case.

The original cases described by Avellis included involvement of the vagus and glossopharyngeal nerves only, and the case herein reported is of a similar pattern, whereas a review of the literature indicates that concomitant involvement of the neighboring cranial nerves was observed in many of the published cases.

A plea has been made by some authors to discard the term "syndrome of Avellis" and other similar terms in favor of one indicative of the site of the lesion. On the basis of this suggestion, the case herein reported would be classified as the jugular foramen syndrome.

1205 St. Paul Street.

ESCAPE OF CEREBROSPINAL FLUID INTO THE WOUNDS OF OPERATIONS ON THE TEMPORAL BONE

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AN INJURY to the dura which permits cerebrospinal fluid to escape into the wound during the course of a mastoidectomy might seem alarming because of the serious implication of impending meningitis. Such an incident, however, seldom has been of great significance in our experience. It actually has been of no more importance than has been an injury of the sigmoid sinus. Neither complication is desired and should be avoided. This, however, is not always possible, especially when extensive pathologic changes involving the dura or the wall of the sinus are encountered.

Fortunately, both incidents are of rare occurrence, but when such injuries occur, unless a precedent has been established for management, the surgeon could be expected to feel considerable anxiety.

REVIEW OF THE LITERATURE

In the cases reported in the literature the cerebrospinal fluid escaped through the ear or the adjacent mastoid structure chiefly in consequence of trauma and fracture of the skull. Twenty-two cases in which escape of cerebrospinal fluid occurred spontaneously at operation or after operation have been recorded in the literature as far as we can ascertain.

While cases of head injury in which a clear watery fluid escaped from the ear were reported as early as 1727, by Stalpartuis Vander Wiel,[1] many years before the discovery of cerebrospinal fluid, only 3 cases of cerebrospinal otorrhea resulting from causes other than trauma were reported before 1913. At that time Canfield[2] presented the first description of a method of repair of a postoperative fistula of the dura.

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1. Vander Wiel, Stalpartuis, cited by Levinson, A.: Cerebrospinal Fluid in Health and in Disease, St. Louis, C. V. Mosby Company, 1919, p. 19.

2. Canfield, R. B.: Some Conditions Associated with the Loss of Cerebrospinal Fluid, Ann. Otol., Rhin. & Laryng. **22**:604-622 (Sept.) 1913.

Escat in 1897 reported a case of cerebrospinal otorrhea of spontaneous origin. No antecedent history of infection or of trauma was obtained in this case. The characteristics of the escaping fluid left little doubt that it was cerebrospinal fluid. The fistula was present in the inner third of the external auditory canal. This is the only case of spontaneous cerebrospinal otorrhea mentioned by Thomson [3] in 1899, in his monograph on cerebrospinal fluid, and by Ballance [4] in 1919.

Cott [5] in 1909 reported 2 cases of spontaneous aural discharge of fluid. One of these cases was that of a young man who had severe nosebleed after submucous resection. He blew his nose frequently and violently to dislodge clots of blood from his nose. Otorrhea occurred after spontaneous rupture of an ear drum. The nature of the escaping fluid was not determined. This may have been a serous fluid secondary to hematootitis media. In the other case cerebrospinal fluid escaped from an ear following radical mastoidectomy. It seems more likely that the fistula was due to a defect of the dura unnoticed in the course of the mastoidectomy than that it was of congenital origin.

In 1913 Canfield reported the first successful repair of a postoperative fistula of the dura. In this case sudden and profuse flow of cerebrospinal fluid from the ear occurred two days after labyrinthectomy had been performed. The flow was so profuse that the bedclothes were saturated. The patient passed into a state of coma. Secondary operation revealed a defect of the cerebellar dura close to the region of the endolymphatic sac. The defect was tamponed with a piece of dura taken from a dog. Recovery, thereafter, was rapid and complete. One of us (H. I. L.) was a house officer at that time and saw this patient.

In the same paper Canfield described 3 other cases in which after operation cerebrospinal fluid escaped from the ear. In one case, he attributed the flow to a probable dislocation of the stapes which exposed the perilymphatic space. In another case, a Hinsberg type of labyrinthectomy had been performed, so it is probable that the fluid issued from the perilymphatic space in this case also. In the third case the flow followed surgical treatment of an extensive cancer of the temporal bone.

Bruges [6] in 1921 reported a case of cerebrospinal otorrhea in which the patient had had chronic otitis media thirty years previously and had

3. Thomson, St. C.: The Cerebrospinal Fluid: Its Spontaneous Escape from the Nose, New York, William Wood & Company, 1899.

4. Ballance, C. A.: Essays on the Surgery of the Temporal Bone, London, The Macmillan Company, 1919, vol. 2, p. 509.

5. Cott, G. F.: Spontaneous Discharge of Cerebro-Spinal Fluid from the Ear, J. Laryng. & Otol. **24**:74-76 (Feb.) 1909.

6. Bruges, D. van C.: Spontaneous Escape of Cerebrospinal Fluid from the Ear, abstracted, J. Laryng. & Otol. **37**:574, 1922.

had active aural discharge for five years thereafter. The aural flow of cerebrospinal fluid occurred without immediate cause. The author considered this a case of spontaneous otorrhea.

In 1931 Roth [7] described a case of cerebrospinal otorrhea in which the amount of cerebrospinal fluid escaping was so slight that it was necessary for the patient to make three visits to the physician in order for the latter to collect enough fluid for analysis. The patient had had two operations on the mastoid process prior to the onset of the cerebrospinal otorrhea.

In the same year Murphy [8] mentioned a case in which cerebrospinal otorrhea occurred during an operation for sectioning of the gasserian ganglion. In this instance, the zygomatic root was pneumatized extensively, and the cell spaces had been opened unintentionally while the opening in the bone was being made.

Kline [9] in 1933 described an aural flow of cerebrospinal fluid that suddenly occurred when the patient was stooping over to touch the floor. The patient, 54 years old, had had severe acute otitis media in infancy and had a residual impairment of hearing in this ear. The patient died within a week, of pneumococcic meningitis. At necropsy a fistula, 2.5 mm. in diameter, was found in the dura overlying a defect in the superior surface of the petrous bone. The fistula opened into the middle ear. The author considered the possibility that the bony defect formed during the otitis in infancy, but he preferred to believe that it was of congenital origin.

Dandy [10] in 1944 reported 5 cases of postoperative cerebrospinal otorrhea, in 4 of which the otorrhea followed mastoidectomy. In the fifth it occurred after removal of a tumor of the acoustic nerve. In 3 of Dandy's cases and in 1 of ours, meningitis developed during the period in which the otorrhea was present. Dench [11] described a case in which the patient refused to submit to surgical repair of a cerebrospinal fistula of the ear. Six months later the patient died of meningitis. The use of penicillin and of sulfonamide compounds has brought some improvement in the prognosis of meningitis, but the danger of the occurrence of meningitis is still serious.

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7. Roth, E.: The Discharge of Cerebrospinal Fluid from the External Auditory Canal, Arch. Otolaryng. **13**:439-442 (March) 1931.

8. Murphy, A. B.: Fracture of the Skull Complicated by Drainage of Spinal Fluid from the Ear, Laryngoscope **41**:237-241 (April) 1931.

9. Kline, O. R.: Spontaneous Cerebrospinal Otorrhea, Arch. Otolaryng. **18**:34-39 (July) 1933.

10. Dandy, W. E.: Treatment of Rhinorrhea and Otorrhea, Arch. Surg. **49**:75-85 (Aug.) 1944.

11. Dench, E. B.: Some Remarks on Labyrinthine Surgery, Laryngoscope **35**:579-585 (Aug.) 1925.

ANATOMIC CHARACTERISTICS OF THE DURA

Fortunately, the normal dura is markedly resistant to trauma. It is a thick, inelastic membrane composed of an inner or meningeal layer and an outer or endosteal layer; these layers are close together except where they separate to form sinuses for the passage of venous blood. The outer layer serves as periosteum for the internal surface of the cranial bones. Its thick collagenous fibers are arranged in bundles. The inner layer is thinner. Its fibers are finer, and they form an almost continuous sheet. These fibers run in a direction at right angles to those of the outer layer.[12]

The temporosphenoid dura overlying the mastoid antrum and the epitympanum is the portion most frequently uncovered during a mastoidectomy. Dench,[12] in his report on accidental wounds of the dura, described 6 cases in which this was the site of the injury. Dandy stated that this is the most common site of postoperative cerebrospinal fistulas. In 4 of his cases the fistula occurred in this portion of the dura. In our own series of 4 cases the fistula occurred in this site in 3.

CAUSES OF INJURY OF THE DURA

Simple exposure of the dura does not cause a fistula, for the dura is exposed numerous times, either purposefully or incidentally, without untoward effect by all surgeons who operate on the mastoid process.

Any pathologic process which causes partial dissolution of the dura makes the occurrence of a dural defect a distinct possibility. Even when this possibility is recognized grossly and great caution is taken to avoid any further injury to the dura, the fistula may occur.

Several anatomic and pathologic conditions may predispose the dura to sustain injury during the course of a mastoidectomy. One of these may be encountered during a secondary operation on the mastoid process if the surgeon does not know or recognize that the dura was exposed at the time of the original operation and later became adherent to the soft parts in the course of the healing. Preoperative observation might give warning of the possibility. Palpation cannot be relied on absolutely to reveal the information. Roentgenologic examination may show a defect which indicates that the dura is not covered by bone, and with this warning the surgeon should be on guard and separate the parts for exposure of the underlying disease process in such a way that the dura will not be injured.

TECHNIC FOR PREVENTING INJURY OF THE DURA

In a primary operation on the mastoid process, when it is found that the dura of the middle fossa lies at a lower level externally than do the structures of the middle ear and the tympanic antrum, there seems

12. Dench, E. B.: The Treatment of Accidental Wounds of the Dura During Operations upon the Mastoid Process, Laryngoscope **24**:594-599 (June) 1914.

little necessity of direct injury to the dura. However, if the dura needs to be uncovered to permit adequate exposure of the diseased process, then great care must be exercised to prevent spicules of bone from penetrating the dura and to avoid injuring it with sharp gouges or curets. Each surgeon has his own methods for exposing the dura or the sigmoid sinus.

After the dura has been exposed, it is essential that the edges of the bone be explored for spicules that have been insinuated between the edge of the bone and the dura. This can be effected by the use of a round-pointed probe. Exposure of a relatively large portion of the dura is believed to be safer than exposure of a small portion, because it permits better inspection of the edges of the bone, which should be left smooth instead of jagged.

It is the general consensus that in exposing the dura or the sigmoid sinus the use of large beveled gouges is probably the safest method. After a small portion of the dura or the sinus has been exposed and identified, more of the dura may be exposed, if necessary, more safely by pushing the bone to be removed away from the dura instead of toward the dura. The use of dull instruments or at least the dull side of the instrument against the dura insures more safety in the procedure.

It seems unnecessary to emphasize that in using a bone-cutting instrument near the dura it should be used nearly parallel with the dura. In other words, cutting at sharp angles to the dura is hazardous even though the instrument is under good control.

Use of the electrically driven bone-cutting burr, which is actually a multiple curet, may cause injury if control of it is lost.

It is considered to be good surgical technic to keep the field sufficiently clear of blood so that details can be seen accurately. This may be accomplished satisfactorily in mastoidectomy by controlling bleeding points, flushing the cavity with water, using suction to clear the cavity and by sponging.

When the dura is involved by extensive disease, its characteristic resistance to trauma changes. If, as the result of an epidural abscess, granulations are present, it means that the outer layer of the dura has been affected. Any unnecessary manipulation or disturbance of the granulation tissue may result in perforation of the dura. It is not necessary to remove this granulation tissue. It may be considered a protective barrier.

If, because of the pressure effect of the insidious growth of cholesteatoma, the dura has become softened and thinner, especially around the posterior aspect of the petrous pyramid, the dura may be injured unintentionally when the cholesteatoma is removed. This fact may seem an argument in favor of leaving the basement membrane of the cholesteatoma intact, but if the dura is found to be softened, it would be impossible to

identify the line of cleavage between the basement membrane of the cholesteatoma and the outer layer of the dura. No vestige of cholesteatoma should be left, because the purpose of the operation will be defeated by the continued growth of the tumor.

In operations on the petrous pyramid the separation of adhesions may cause injury to the dura which is hardly possible to avoid and extremely difficult to repair.

SURGICAL TREATMENT OF DEFECTS OF THE DURA

When postoperative cerebrospinal otorrhea persists for longer than three weeks and the drainage does not diminish, the fistula probably will not heal spontaneously. The notable exceptions are those instances in which the fluid escapes from a fistula in the bony labyrinth. In such cases, almost without exception, the fistula heals without specific treatment. This probably is due in part to the relatively long channel through which the cerebrospinal fluid must pass. If the fistula does not heal, surgical treatment is necessitated.

When a defect of the dura is recognized at the time of operation or is sought for in a secondary operation, of primary importance in the effective closure is insuring that approximation of the edges of the defect has been effected. This may be accomplished in several ways.

Careful search must be made for all fragments of bone in the region of the dural injury, and they must be removed. Sharp edges of bone, which cause perforation of the dura by pressure necrosis, should be rounded off. When the dura is weakened by a disease process, bone should be removed until normal-looking dura is exposed in order to allow the normal dura at the periphery of the defect to bear the pressure of the brain.

Silk sutures can be used safely to approximate the torn edges of the dura, or if the use of sutures is not feasible because of the friability of the dura, soluble "cellucotton" can be packed against the injured region, or animal membrane can be laid across the rent to prevent brain tissue from herniating through the hiatus.

In 4 cases reported by Lillie [13] in 1944, in which a Neumann type of labyrinthectomy was performed, cerebrospinal fluid began to escape through a defect in the cerebellar dura in the course of the operation. In each instance the injured dura was treated in the manner just described. No untoward postoperative symptoms referable to the escape of cerebrospinal fluid occurred, and the flow of cerebrospinal fluid ceased by the time the patient was dismissed from the hospital. Careful investigation of the injured dura at the time of the injury and immediate

13. Lillie, H. I.: Critical Review of Patients Subjected to Labyrinth Operations, Ann. Otol., Rhin. & Laryng. **53**:207-220 (June) 1944.

repair are instrumental in rendering penetration of the dura a relatively harmless accident.

In cases in which the dural defect is too large to permit approximation of the edges, the defect can be tamponed with animal membrane as suggested by Canfield, or a portion of the fascia from the temporal muscle can be sutured over the opening. In 1 of our cases, the dural defect was approximately 1 inch (2.5 cm.) in diameter. The dural margin was pressed against the brain by placing absorbable "cellucotton" into the space between the bone and the dura. This effectively blocked off the subarachnoid space from the defect and kept the region dry. The integument lining the mastoid cavity was deflected over the opening, and the mastoid cavity was packed.

REPORT OF CASES

CASE 1.—A man 32 years old underwent radical mastoidectomy on the right ear in 1939 because of chronic suppurative otitis media and purulent otorrhea of many years' duration. After that a clear watery fluid drained from the right ear; the amount of drainage usually was scanty, but it became copious during physical exertion. He had never had symptoms of meningeal involvement. Because of the aural discharge, he came to the Mayo Clinic for the first time on Aug. 8, 1945.

Physical examination of the right ear revealed the cavity resultant from radical mastoidectomy. A smooth gray mass occupied the region of the mastoid antrum and the middle ear. The mass had the appearance of bulging dura, but it could not be determined whether brain tissue filled the mass. A pulsating stream of clear watery fluid could be seen trickling down the anterior surface of the mass into the external auditory canal.

During the course of examinations at the clinic the amount of discharge from the ear increased abruptly and markedly; so the patient was hospitalized for completion of the examinations and for prophylactic administration of sulfadiazine and penicillin.

After the examinations were completed, the mastoid cavity was exposed through a postauricular incision, and the integument lining the cavity was cautiously reflected. It was evident that the tegmental plate over the mastoid antrum and middle ear had been removed at the previous operation. Dura had bulged through the defect and filled the region of the mastoid antrum and middle ear. This was identified as the mass visible in the mastoid cavity on external examination. A spicule of bone on the anterior margin of the bony defect projected through a 2 cm. tear in the dura. Brain tissue could be seen bulging into the dural defect, and cerebrospinal fluid was escaping through it.

The bone was removed widely from around the fistula and a silk suture was inserted to approximate the gaping edges of the torn dura. A piece of animal membrane was laid over the entire part of the exposed dura, the edges of the membrane being forced into the space between the edge of the bone and the dura. A strip of petrolatum gauze was packed into the mastoid cavity to give support to the repaired dura. Recovery was uneventful, and the ear remained dry. The patient was kept under observation until epithelization of the cavity was well established.

CASE 2.—A 16 year old boy underwent bilateral complete mastoidectomy in 1926 and recovered satisfactorily. In April 1935, after he had had a sore throat, an

infection, which involved the sigmoid sinus, developed in the left mastoid process, and thrombosis of the sigmoid sinus and streptococcic meningitis resulted. The jugular vein was ligated, and the thrombus was removed from the sigmoid sinus. The patient made a gradual recovery. The operative wound continued to discharge pus for several months and then healed, leaving a large, bulging mass beneath the scar of the incision over the mastoid process.

The patient came to the clinic for the first time on Oct. 7, 1935, for treatment because, he said, the mass was increasing in size. On examination the patient was found to be normal except for the otologic condition. A large bluish mass could be seen bulging from the mastoidectomy scar behind the left ear. It was pulsating and could be flattened by pressing on it. The external auditory canal was dry. The clinical impression was that the mass was either a cerebellar herniation or an aneurysm of the sigmoid sinus. After consultation with the neurosurgeons it was decided that the mass should be observed for a time before surgical exploration was advised.

Two months later the mass was larger than before. The left mastoid process was then explored through a postauricular incision. The mass occupied the entire cavity. It was traced to its origin and dissected out. It was a herniation of the inner wall of the sigmoid sinus and contained cerebellar tissue. The sac was friable and, in the course of operation, an opening was made into the subarachnoid space. A considerable amount of cerebrospinal fluid escaped. The fragility of the dura in this region made it inadvisable to insert silk sutures; so a piece of animal membrane was laid over the entire region of exposed dura. This was held in place by a petrolatum gauze pack. After ten days the pack was removed. A small amount of cerebrospinal fluid began to flow into the cavity, but the flow gradually diminished and finally disappeared in the course of postoperative treatment.

Follow-up observations of this patient were frequent. In due time he resumed a normal life, taking part in athletic sports and attending college. When last heard from, in 1942, he was a member of the United States armed forces.

CASE 3.—A man aged 55 years came to the clinic on Aug. 26, 1934, because of increasing discomfort in the region of the right ear, characterized by a feeling of fulness and pressure. Intermittent purulent otorrhea had begun in 1896, and a polyp had been removed from the ear in 1902. He had not noticed any discharge from this ear for eighteen years prior to the time at which he was examined in the clinic.

Examination gave negative results except for the findings relative to the right ear. Granulation tissue filled the fundus of the external auditory canal, and a trace of watery discharge was seen on the floor of the canal. A large posterior defect leading into the attic was found, from which masses of cholesteatoma were removed. A roentgenogram of the mastoid process showed a large area of destruction of bone involving the mastoid process, the zygoma and the squama. Radical mastoidectomy was advised.

At operation a large cholesteatoma was found, which had excavated the entire posterior aspect of temporal bone except the otic capsule. The dura was exposed throughout the operative field. Above the labyrinth the dura was granular and red and was bound down to the roof of the labyrinth by adhesions. While the cholesteatoma was being removed from this site, the subarachnoid space was entered, and a free flow of cerebrospinal fluid occurred. All rough edges of the cortical bone in this region were removed, and an iodoform gauze pack was placed against the dural defect to encourage reparative formation of adhesions. A petrolatum gauze pack was placed below this for support.

Cerebrospinal fluid flowed into the cavity for several days during the postoperative period, but the amount decreased gradually. When the patient was dismissed, the ear was dry. Two years later the ear was still dry and no herniation had occurred.

CASE 4.—A man 44 years old underwent complete mastoidectomy of the right ear in 1918 for acute mastoiditis. He had no trouble with this ear after that. In May 1942 he underwent modified radical mastoidectomy of the left ear because of chronic suppurative otitis media and purulent discharge of two years' duration. In January 1945 the drainage of the left ear began to increase. During March the patient had three episodes of chills, fever, headache and vomiting; each attack lasted three days. During each episode the otorrhea was more profuse than at other times. Radical mastoidectomy was performed on the left ear in August 1945 because of an episode of chills, fever, headache, vomiting and loss of consciousness. After this operation the patient had symptoms of vertigo, tinnitus, impairment of hearing and occasional generalized headache for several weeks and a slight watery aural discharge, which had persisted up to the time at which he was examined at the clinic.

The patient came to the clinic for the first time on April 9, 1946, for treatment of the left ear. The physical and neurologic examinations revealed no abnormalities except for the findings in the left ear. On examination of this ear the cavity made in the course of radical mastoidectomy was observed. A pulsating flow of watery material was issuing from a fistula on the posterior surface of the cavity. The patient had been told that a cyst of the dura had been encountered in the course of the operation in August 1945. The physical findings and the history were suggestive of the presence of a cerebrospinal fistula complicated by recurrent attacks of meningism or meningitis.

Exploration of the left mastoid process was advised, and after four days of preparatory administration of sulfadiazine and penicillin the operation was performed on April 15. After the mastoid cavity had been opened, the integument lining it was freed carefully from the underlying attachment. A large circular defect of the bone of the posterior part of the cavity was found, and the dura under the defect was absent. Some brain substance protruded through this opening and was attached by scar tissue to the integument lining the mastoid cavity. A free flow of cerebrospinal fluid occurred while the defect was being repaired. Edges of the bone around the defect were removed, and a margin of normal dura was exposed about the defect. Soluble "cellucotton" was packed into the space between the dura and the bone in order to seal off the subarachnoid space, and additional "cellucotton" was laid over the exposed brain tissue. The integument was then laid over this, and a petrolatum gauze pack was inserted into the mastoid cavity for support of the integument. Recovery was uneventful. The ear has so far remained dry.

SUMMARY AND CONCLUSIONS

The available literature pertaining to postoperative cerebrospinal otorrhea is reviewed. The factors involved in the origin of a cerebrospinal fistula are described, and means of preventing the formation of a permanent cerebrospinal fistula are discussed. Methods which have been found successful for the repair of dural defects of various sizes in 4 cases are described.

Although cerebrospinal fluid escaping into a mastoidectomy wound at the time of operation or subsequently rightfully may be thought to forebode a dangerous complication, the experiences reported seem to indicate that the difficulties may be overcome by surgical methods.

It would appear obvious that should an injury be done to the dura which permits the escape of cerebrospinal fluid during an operation on the mastoid process the defect should be closed immediately rather than at a subsequent operation.

In case the escape of cerebrospinal fluid occurs as the result of a dislocation of the stapes, the precedent established is that any surgical intervention be deferred, because the escape of the fluid is usually controlled by natural reparative processes.

While it actually seems that when cerebrospinal fluid escapes into the mastoidectomy wound the wound apparently clears of evidence of infection rapidly, such a phenomenon should not be relied on. The present day prophylactic use of penicillin and chemotherapeutic drugs is extremely beneficial, and the results are reassuring. They are administered preoperatively and postoperatively. These preparations were not available for use except in recently encountered cases.

"INTOCOSTRIN" — PENTOTHAL SODIUM ANESTHESIA FOR BRONCHOSCOPY AND LARYNGOSCOPY

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AFTER using curare with cocainization for endoscopy in 20 cases, Silverberg and Ansbro [1] concluded, "We do not feel that curare may be used for endoscopy with safety," and in discussing this paper Dr. M. C. Meyerson stated, "I would summarize my remarks by saying that if bronchoscopy had to be done with curare, I would prefer not to perform bronchoscopy."

However, after using a combination of "intocostrin" (a curare preparation) and pentothal sodium for laryngoscopy and bronchoscopy in 27 cases, we feel that this combination has much to offer. These procedures are not pleasant, to begin with, even with perfect premedication and the most skilful cocainization. Furthermore, if the patient is uncooperative, the procedure becomes a trial to every one in the operating room. In many patients, despite the cocainization, the laryngeal reflex remains quite active, and difficulty is encountered in exposing the larynx and vocal cords. In addition the larynx, vocal cords and trachea are traumatized, so that the patient frequently complains of soreness of the throat and difficulty in talking after laryngoscopy.

Furthermore, in using "intocostrin" and pentothal sodium in combination a minimal amount of each is required to produce the condition necessary for successful endoscopy. Therefore, the bronchoscopist works under the ideal condition of muscular relaxation and quiescence with safety, which facilitates his work so that careful and accurate examination of the exposed regions may be made. The patient is particularly appreciative of this type of anesthesia.

TECHNIC OF ADMINISTRATION

The patient is prepared in the same manner as he would be if he was to be given only an intravenous injection of a solution of penthothal sodium as an anesthetic. The premedication is based on his age, size and apparent metabolic and emotional state. It may include a barbiturate, such as vinbarbital sodium

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1. Silverberg, J. S., and Ansbro, F. P.: An Evaluation of the Use of Curare in Endoscopy, New York State J. Med. **44**:2468 (Nov. 15) 1944.

Summary of Cases in Which "Intocostrin" and Pentothal Sodium Were Administered

Patient	Sex	Age	Operative Procedure	Operative Time, Min.	Total Amount of "Intocostrin," Units *	Total Amount of Solution of Pentothal Sodium, Cc.	Relaxation	Comment
1	F	47	Laryngoscopy, biopsy, cauterization	20	40	16	Good	Recovered
2	M	36	Laryngoscopy, cauterization of cord	16	40	33	Good	Recovered
3	G	47	Laryngoscopy	20	36	23	Good	Respiration depressed; recovered
4	F	48	Laryngoscopy, removal of laryngeal tumor	11	30	15	Good	Recovered
5	M	34	Laryngoscopy, removal of tumor, cauterization	8	40	20	Good	Recovered
6	F	27	Bronchoscopy, biopsy of right bronchus	31	120	25	Good	Recovered
7	M	62	Laryngoscopy, biopsy of cords	42	40	45	Good	Recovered
8	M	36	Laryngoscopy, cauterization of vocal cords after removal of tumor	18	80	19	Good	Recovered
9	M	50	Lynch suspension laryngoscopy	20	60	6	Good	Marked respiratory depression; neostigmine given in O. R.; recovered in 20 min.
10	F	40	Bronchoscopy	20	40	15	Good	Recovered
11	F	27	Bronchoscopy, biopsy of bronchus	28	30	30	Fair	Recovered
12	M	54	Laryngoscopy, biopsy of vocal cord	43	40	20	Good	Laryngeal spasm; recovered
13	M	41	Laryngoscopy	21	60	14	Good	Recovered
14	F	?	Laryngoscopy, biopsy	30	60	20	Good	Recovered
15	M	45	Laryngoscopy, cauterization of vocal cords	30	36	40	Good	Recovered
16	F	45	Laryngoscopy	5	20	17	Good	Recovered
17	F	23	Laryngoscopy, cauterization of cord	22	30	30	Good	Bronchospasm; recovered
18	F	75	Laryngoscopy, cauterization of right vocal cord	19	30	15	Good	Recovered
19	F	41	Bronchoscopy	36	52	51	Good	Coughed some during procedure; recovered
20	F	67	Laryngoscopy	31	40	42	Good	Recovered
21	M	35	Laryngoscopy	20	60	26	Good	Recovered
22	F	?	Laryngeal biopsy	36	50	27	Good	Recovered; condition fair
23	M	62	Bronchoscopy with biopsy of right minor bronchus	24	48	32	Good	Recovered
24	M	58	Laryngoscopy, biopsy, cauterization of vocal cord	20	60	30	Good	Recovered
25	F	55	Laryngoscopy, biopsy, cauterization of cords, removal of tumor	30	60	22	Good	Recovered
26	F	76	Bronchoscopy	24	50	17	Good	Recovered
27	M	42	Excision of tumor of vocal cord	15	70	40	Good	Recovered

* One unit equals 0.15 mg. of d-tubocurarine chloride.

("delvinal sodium" N.N.R.) 1½ to 3 grains (0.096 to 0.19 Gm.), given one and one-half hours before operation. Morphine sulfate or neperidine hydrochloride ("demerol hydrochloride" N.N.R.) is always given in small doses, with atropine sulfate, 1/300 to 1/100 grain (0.22 to 0.65 mg.), one hour before operation. The patient is placed on the table, with his head resting on the head rest designed by one of us (S. R.). The use of this head rest greatly facilitates the exposure of the larynx and vocal cords and allows the bronchoscopist to insert the bronchoscopic tube with more ease.

The arm of the patient is placed at his side on an arm board and cleansed with alcohol. A no. 18 or no. 19 gage needle is inserted. "Intocostrin" solution is then administered slowly, and the patient is asked to tell the anesthesiologist when he begins to feel his lower jaw relax and begins to have difficulty in raising his head. When this point is reached, the patient will have received from 20 to 60 units of "intocostrin" (equivalent to 3 to 9 mg. of d-tubocurarine chloride) in a period of two to three minutes. The full effects of "intocostrin" are obtained before administering pentothal sodium and this occurs within three minutes. A 2.5 per cent solution of pentothal sodium is then administered slowly until the lid reflex is abolished. Then the patient is ready for bronchoscopy. Oxygen is administered by oral insufflation throughout the entire procedure. The pentothal sodium and "intocostrin" solutions are then administered as necessary to maintain even anesthesia.

The initial dose of "intocostrin" will usually be about 40 units, and this amount is sufficient for the usual laryngoscopy or bronchoscopy. For the induction of anesthesia 5 to 10 cc. of the solution of penthothal sodium is usually necessary. On completion of the operation 2 cc. of picrotoxin injection U.S.P. is given intravenously, and the majority of patients will respond before leaving the operating room to the extent of swallowing and return of muscle tonus.

In our series of 27 cases, good relaxation was obtained in all but 1 patient, as seen from the accompanying table. Respiratory depression of a severe nature was encountered in 1 patient, necessitating the use of neostigmine; following the administration of neostigmine, the patient's respiration improved. The procedure described should not be attempted unless the anesthesiologist is prepared to combat respiratory depression and institute artificial respiration immediately by means of a gas machine. One cubic centimeter of a 1:2,000 solution of neostigmine methylsulfate should be prepared and given if thought necessary. Oxygen should be given continuously to maintain a high oxygen concentration. The use of the head rest has greatly facilitated the exposure of the larynx and the visualization of the vocal cords.

SUMMARY

"Intocostrin"–pentothal sodium anesthesia was used in 27 cases of laryngoscopy and bronchoscopy.

Relaxation was good in the majority of patients, allowing the bronchoscopist to work under ideal conditions.

Respiratory depression was encountered in only 2 patients.

The technic described is safe when administered by a competent anesthesiologist.

NOTE.—Since submitting this report we have used this technic in 96 cases.

NEW ANALGESIC FOR THE PRACTICE OF OTOLARYNGOLOGY

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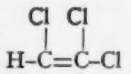
BOSTON

THE ANALGESIC properties of trichloroethylene were accidentally discovered during World War I.[1] It was applied at that time principally for the relief of trigeminal neuralgia. The fact that it is still a part of the physician's armamentarium is indicative of its safety and low toxicity. It has been used, however, as a general anesthetic both in this country and elsewhere. The purpose of this paper is to present a report on the properties and uses of trichloroethylene as an analgesic and not as a general anesthetic.[1]

I first used trichloroethylene on myself during the drilling of a live carious tooth without the use of local anesthesia. The trial was both convincing and gratifying, because no pain was felt. A sensation of numbness was experienced not only about the teeth but all over the body. In addition both psychologic and physical relaxation were noted. These reactions subsided within two minutes after the drug was applied, and there were no after-effects, such as nausea, vomiting or weakness. I was convinced that it had useful properties as an aid in the field of otolaryngology and rhinoplastic surgery.

Trichloroethylene has the chemical formula[2] of:



It is an unsaturated halogenated hydrocarbon and is known commercially under the names "trychlo," "trilene," "chlorylene" and "westrosol," among others.

The drug is a clear colorless noninflammable liquid possessing an odor something like that of chloroform. It is heavier than water; light and heat cause it to decompose rapidly into acid products. Its wide margin of safety and its low toxicity are demonstrated in the reports from several laboratories, viz:

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1. Adriani, J.: The Chemistry of Anesthesia, Springfield, Ill., Charles C Thomas, Publisher, 1946.

2. Waters, R. M.; Orth, O. S., and Gillespie, N. A.: Anesthesiology **4**:1, 1943.

Herzburg [3] kept dogs anesthetized with trichloroethylene for three hours and found, at postmortem examination, no gross or microscopic pathologic changes in any of the vital organs.

Striker and co-workers [4] used it in over 300 cases as a short-acting anesthetic for minor operations. In many instances only analgesia was produced. The drug was regarded as satisfactory as an anesthetic.

Hewer [5] reported that trichloroethylene was a potent analgesic and nontoxic.

Hill [6] reported experimental observations made with trichloroethylene, which have been confirmed by me to wit: 1. It is pleasant. 2. There is no irritation of the nasal mucosa. 3. There is a feeling of relaxation and well-being. 4. A tingling sensation is felt in the extremities, and there is a transient sensation of vertigo. 5. Recovery is rapid. In addition to this, I have observed that: 6. The pupils dilate temporarily. 7. There is loss of sensitivity of the skin; pricking of the skin with a needle does not bother the patient. From the last observation it was concluded that injections of penicillin or other antibiotics would not cause discomfort. The analgesia produced removed not only apprehension but discomfort as well.

ADMINISTRATION

One cubic centimeter of trichloroethylene [7] is poured on a surgical sponge, and the patient holds it over his nose, allowing some air to be inhaled with the fumes. After 15 to 20 inhalations a state of general analgesia is obtained. The patient will tell when she feels "woozy" and has "tingling" sensations in the arms and legs. There may be a generalized feeling of euphoria, sometimes developing into a laugh such as takes place in the early stages of nitrous oxide anesthesia. In children the anesthetic properties accumulate rapidly, so that after 3 or 4 inhalations the patient may become completely relaxed, and no further application of the drug is necessary. This was demonstrated on a child of my family who had to undergo paracentesis of the ear drum. The operator can do whatever is necessary while the patient continues to inhale the fumes. Usually one application is sufficient; however, in some cases more of the solution must be applied to the sponge.

When the sponge is removed, there is complete recovery within two minutes. There are no after-effects, and an empty stomach prior to the administration is not necessary.

Those otolaryngologists who do rhinoplastic operations know that patients fear the injections by which local anesthesia is induced and the postoperative removal of the sutures. Trichloroethylene inhalations dispense with this apprehension. The anesthetic which is injected along

3. Herzburg, M.: Anesth. & Analg. **13**:203, 1934.

4. Striker, C.; Goldblatt, S.; Warm, I. S., and Jackson, D. E.: Anesth. & Analg. **14**:48, 1935.

5. Hewer, C. L.: Proc. Roy. Soc. Med. **34**:463, 1942.

6. Hill, B.: Proc. Roy. Soc. Med. **37**:475, 1944.

7. "Trychlo" was used.

the membranous septum, the columella and the lobule is painful and causes sneezing and restlessness on the part of the patient, which is annoying to the operator. Within twenty seconds this drug dispels any discomfort.

During a rhinoplastic operation, when there is excessive bleeding, trichloroethylene perceptibly diminishes the flow of blood. Observations have been made during the removal of nasal polyps. Not only was there good analgesia but temporary hemostasis. Therefore, in a case of excessive bleeding the inhalation of trichloroethylene would not only induce relaxation on the part of the patient but provide temporary hemostasis during the operation.

Knowing the excellent and instant pain-relieving qualities, the safety and the nontoxicity of this drug, I have used it with good results also in otitis media when paracentesis was indicated.

During the days before the war, when beds and anesthetists were available, patients were sent to the hospital for paracentesis of the ear drum. Today one must do all one can for the patient in the office and at home. Paracentesis can be performed without trouble while the patient administers the drug.

Intranasal puncture of a maxillary sinus of a patient who is under local anesthesia is never comfortable, and the patient invariably complains of pain during the operation. Here again trichloroethylene is useful.

ILLUSTRATIVE CASES

Two cases have been chosen to illustrate the typical application of trichloroethylene in the office:

1. A man 59 years of age came to the office with a history of headaches of seven years' duration. The pain was relieved only by repeated use of "bromo-seltzer" [8] during the day. There was occasional nasal obstruction as well as postnasal discharge, mucoid in character.

Examination revealed no tonsils. The teeth were in good condition. There were an irregular septum, a good airway and clear meatuses; there was no purulent discharge. Transillumination showed the sinuses clear. The ears were not abnormal. The family physician, in a general physical examination, found that the blood pressure was 148 systolic and 80 diastolic; the heart, the lungs and the urine were normal.

Treatment consisted in the substitution of trichloroethylene for "bromo-seltzer." The patient used trichloroethylene three or four times a day at first. Within two weeks his headaches had disappeared. Occasional headaches are now relieved by a single application. These headaches are of nervous origin, due to excitement and apprehension, and are readily relieved with self-administered trichloroethylene.

2. After an acute infection of the upper respiratory tract a 36 year old woman suffered from a choking sensation and cough, which were not relieved by gargles,

8. Each dose contains 2.5 to 3.5 grains (0.16 to 0.22 Gm.) of acetanilid and 5 to 7 grains (0.32 to 0.45 Gm.) of sodium bromide.

inhalations of steam, lozenges or gum. Relief was immediate when trichloroethylene was inhaled. It has antispasmodic properties for the relief of choking spasms due to pharyngitis, tracheitis or bronchitis.

I have found trichloroethylene effective also (1) in opening circumscribed furuncles in the external auditory canals; (2) in preparing patients for intramuscular injections of penicillin and other medicaments; (3) in removing dry nasal packs from the nose or foreign bodies from the nose and the auditory canal; (4) in removing tonsillar tabs and hyperplastic lymphoid tissue by electrocoagulation; (5) in removing impacted cerumen from painful external auditory canals.

Cases in Which Trichloroethylene Has Been Used

Condition or Operation	Success	Failure
Removal of nasal sutures	12	4
Puncture and irrigation of the maxillary antrum	6	1
Nasal polypectomy	3	0
Removal of stubborn nasal packs	2	0
Headaches of nervous origin	46	10
Paracentesis of ear drum	5	0
Earache	1	0
Opening circumscribed furuncle of exterior auditory canal	2	0
Removal of impacted cerumen of painful canal	4	0
Electrocoagulation of tonsillar tabs and lymphoid tissue	5	0
Choking spasm due to tracheitis and bronchitis	5	0
Painful intramuscular injections	43	1
Total	134	16

CONCLUSIONS

Trichloroethylene is valuable in the practice of otolaryngology and rhinoplastic surgery as a pain reliever. It is not only safe but nontoxic. It is quick to produce analgesia, and its effects wear off rapidly. No special apparatus is required. It is pleasant, and there are no irritating effects, local or systemic. The patient also enjoys a sensation of relaxation and well-being. It is a great time saver, and in many cases it saves hospitalization.

475 Commonwealh Avenue.

Case Reports

CHRONIC ABSCESS OF THE NASAL SEPTUM

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CHICAGO

ACUTE abscess of the nasal septum is most frequently observed as a result of trauma inflicted on the septum from within or from outside the nose, including improper operative treatment of the septum or of some other part of the nasal cavity. Rarely it is seen as a complication of infectious periodontitis traveling through the incisor foramen.

In contrast to the well known acute abscess of the septum, chronic abscess of the septum is not mentioned in the literature except as a rare occurrence associated with rhinoliths.[1]

This case report concerns a well nourished 36 year old white man. He began to suffer from nasal obstruction, especially on the right side, during January 1945. When a child he fell from an ice wagon, striking the streetcar tracks

Fig. 1.—Narrowing of the right vestibule by scar contraction of the nasal floor.

and splitting the left side of his forehead. As a result of this accident, he has a deep scar extending from the left side of the forehead through the middle of the left eyebrow up to the dorsum of the nose near the glabella.

In March 1946, owing to symptoms of nasal obstruction, he consulted a general practitioner, who performed a somewhat obscure nasal operation with the patient under general anesthesia. Apparently, this surgical treatment was unsuccessful, and a second similar operation was performed in the following September by the same physician. The result of this operation was complete blockage of the right nasal cavity and gradual closure of the right nasal vestibule. There was also intermittent obstruction and opening of the left side.

From the Department of Laryngology, Rhinology and Otology, University of Illinois College of Medicine.

1. Minkiewicz: Erkrankungen der Luftwege, Gaz. lek. **12**:13, 1885. Seifert, O.: Fremdkoerper in der Nase und Rhinolithen, in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohrenheilkunde mit Einschluss der Grenzgebiete, Berlin, Julius Springer, 1928, vol. 3, p. 876.

The patient was treated with various nose drops and other medicines until the end of January 1946, when he was advised to undergo a further nasal operation.

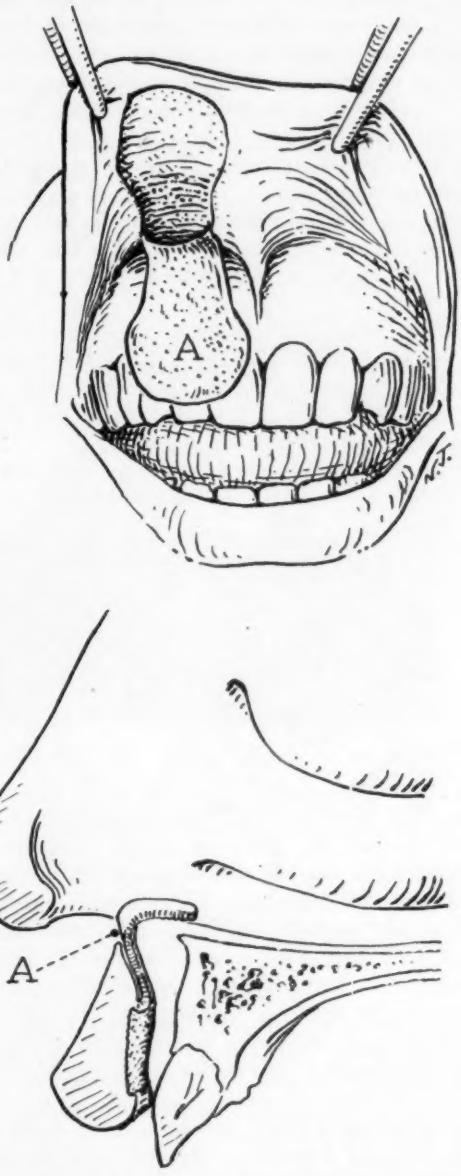

Fig. 2.—Upper drawing: The lifting of a mucous membrane flap, *A*, from the everted upper lip for lining the enlarged right vestibule of the nose.
Lower drawing: The flap, *A*, tunneled into the nasal vestibule.

The patient was first examined by me during the month of March 1946. The clinical findings were as follows: The right nasal vestibule was much narrowed,

owing to scar contraction of the floor starting at the septum (fig. 1). In the right nasal cavity there was a solid tumor mass, covered with mucous membrane, which had grown together with the dorsum, the septum and the lateral nasal wall except for a 2 to 3 mm. channel-like opening on the floor of the nose.

Roentgen examination of the nose and sinuses gave essentially negative results. No erosion of either the septum wall or the medial sinus wall could be detected. There also was a small synechia in the left nasal cavity between the septum and the middle turbinate.

A sufficiently large biopsy specimen of this mass was taken and diagnosed as fibrous adenomatous polyp.

A two stage operation was decided on. In order to remove the tumor mass of the right nasal cavity via submucous resection, a plastic surgical procedure was performed first in July 1946 for the purpose of enlarging the atretic right nasal vestibule.

At the suggestion of Dr. Hans Brunner, a mucous membrane flap was prepared from the patient's everted upper lip, with its wide base in the gingivolabial fold, as demonstrated in figure 2 (upper drawing). For this procedure local anesthesia was produced with a 2 per cent solution of procaine hydrochloride containing epinephrine hydrochloride (1:25,000).

Then throughout the posterior circumference of the right nasal vestibule, the adhesions were widely excised and the posterior margin of the right piriform

Fig. 3.—Successful completion of the plastic procedure.

aperture exposed. The previously prepared mucous membrane flap of the right upper lip was then tunneled through a pocket connecting the nasal vestibule with the mouth and fixed with two silk sutures to the right nostril, thereby entirely lining the excised area of the right nostril, as shown in figure 2 (lower drawing).

The defect in the right upper lip was closed with several interrupted silk sutures.

This operation was successful, as the enlarged opening of the right nasal vestibule was permanent. The only disturbing complication was a small fistula that appeared between the right oral vestibule and the right nostril. This fistula was closed six weeks later, just prior to the second stage of the operation, by curetting its tract and suturing the opening in the upper lip. The end result is shown in figure 3.

On August 22, with intratracheal anesthesia being used, the tumor mass was attacked through a regular submucous resection incision made on the right side of the septum, which was carried over the mucous membrane covering the anterior part of the tumor mass. The septal cartilage was then exposed and removed in front of the mass.

In the area of the tumor mass the septal cartilage could not be differentiated, and it seemed that the mass was adherent to the mucoperichondrium of the septum on the left side. The mass itself consisted of thick fibrous tissue. In the attempt

to separate it from the mucoperichondrium of the left side and from the dorsal attachment, a perforation of the septum was made.

During removal of the tumor mass dorsally from the septum, a cherry-sized old abscess was encountered, containing about 2 to 3 cc. of pus. The fibrous tissue mass was then removed with scissors, and the posterior part of the nose exposed. The right choana was found to be very narrow, but it was cautiously dilated until a gauze tampon could be introduced into the pharynx. After severing the synechia of the left nasal cavity, both sides were packed tight with petrolatum gauze strips.

The postoperative course was uneventful. In about eight days, after removal of the nasal tampons, the patient was able to breathe comfortably.

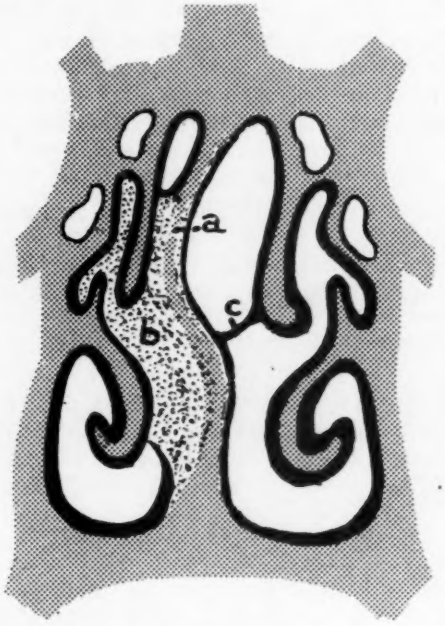

Fig. 4.—Anatomic diagram of the conditions observed in the nose: (*a*) septum; (*b*) abscess; (*c*) synechia.

COMMENT

In this case it is very probable that the septal deviation was the result of the childhood injury. Although it is impossible to state definitely, it is likely that the two operations mentioned in the history were aimed at the correction of the septal deformity but did not achieve the proper result. Instead, a septal abscess and a narrowing of the right nasal vestibule resulted.

The septal abscess became chronic and was surrounded by a thick fibrous capsule (fig. 4) 0.5 cm. in thickness, separating the vestibule from the rest of the nasal cavity.

The treatment consisted of (*a*) an enlargement of the right vestibule and (*b*) drainage of the abscess.

The various plastic surgical methods described in the literature for the correction of an atretic nasal vestibule employed full thickness epidermal grafts taken from the cheek or from the upper lip. These were then rotated to cover the region of the excised scars of the nasal vestibule.[2]

At the suggestion of Dr. Hans Brunner, a mucosal flap of the upper lip was prepared and tunneled into the nasal vestibule (fig. 2).

The results of this simple method were satisfactory. The diagnosis of chronic abscess of the septum was not made prior to surgical intervention. Originally, it was planned to remove the tumor mass by means of a submucous resection. To our surprise, the tumor mass turned out to be a chronic septal abscess, which had grown together with the mucosa on the left side of the septum and had bulged into the right nasal cavity, covered by the septal mucosa of the right side. The abscess was opened; the 0.5 cm.-thick fibrous capsule was excised as far as possible. This procedure resulted in a large perforation of the septal mucosa. The functional result of the operation was satisfactory.

SUMMARY

The rare occurrence of chronic abscess of the nasal septum and its management are discussed.

A simple procedure which was used in enlarging the atretic nasal vestibule by means of a mucous membrane flap taken from the lip is described.

1853 West Polk Street.

2. Joseph, J.: Nasen und sonstige Gesichtsplastik, Leipzig, C. Kabitzsch, 1931, figs. 672 and 673. Fomon, S.: Surgery of Injury and Plastic Repair, Baltimore, William Wood & Company, 1939. Koerner, O.: Ein neues operatives Verfahren zur Besichtigung von Synechien in der Nase, Ztschr. f. Ohrenh. 60:252, 1910. Stupka, W.: Verwachsungen in der Nase, in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohrenheilkunde mit Einschluss der Grenzgebiete, Berlin, Julius Springer, 1928, vol. 3.

Clinical Notes; New Instruments and Technics

USE OF ABSORBABLE GAUZE IN OTOLARYNGOLOGIC PRACTICE

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NEW BRUNSWICK, N. J.

NASAL hemorrhage is a common problem facing physicians in general and otolaryngologists in particular. The anatomic structure of the nose is responsible for this. The general practitioner is frequently called on to control nasal hemorrhages of varying degree that may be caused by a multitude of etiologic factors from trauma to hypertension. As a rule, the otolaryngologist must treat the more resistant of these so-called spontaneous hemorrhages, as well as those caused by trauma.

Even though a nasal hemorrhage seems to be a relatively minor medical entity, it can be a most disconcerting episode and one that will tax the ingenuity of the attending physician. The oxidized gauze and cotton introduced to our medical armamentarium have been among the greatest aids in the treatment of nasal hemorrhage. The use of oxidized gauze for this purpose was first reported by Houser.[1] I have used this material ("hemo-pak" absorbable gauze) in 22 cases of nasal hemorrhage, with prompt and permanent control of the bleeding in each case.

The effectiveness of oxidized gauze in the control of nasal hemorrhage suggested its use in the control of bleeding following intranasal surgical procedures. Absorbable gauze packing and cotton are prepared by nitrogen dioxide oxidation of surgical gauze or cotton by the method of Kenyon and his associates,[2] which converts it to cellulosic acid (polyanhydroglucuronic acid). Oxidation is carried out in such a way that carboxyl groups (-COOH) are formed on carbon 6 at random throughout the long chain of glucose radicals which constitute the cellulose molecule.

The frequency of postoperative hemorrhage following the removal of nasal polypi is surprising and at times discouraging to the patient. This hemorrhage, which is most upsetting to the patient, may take place a few hours after the removal of the polypi or after the removal of the nasal pack, and in the latter case it can be very serious. Because most polypi are found in the middle meatus, where polypoid degeneration of the middle turbinate is common, their removal leaves denuded surfaces that are potentially very vascular to which pressure is not easily applied. Absorbable gauze and cotton offer an ideal postoperative pack in these cases. The gauze can be carefully tucked into all crevices of the

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The absorbable gauze and cotton used in this study were supplied by Johnson & Johnson, New Brunswick, N. J.

1. Houser, K. M.: Oxidized Cellulose Gauze Packing for Nasal Bleeding, J. A. M. A. **132**:143 (Sept. 21) 1946.

2. Yackel, E. C., and Kenyon, W. O.: Oxidation of Cellulose by Nitrogen Dioxide, J. Am. Chem. Soc. **64**:121-127 (Jan.) 1942. Unruh, C. C., and Kenyon, W. O.: Investigation of the Properties of Cellulose Oxidized by Nitrogen Dioxide, ibid. **64**:127-131 (Jan.) 1942.

middle meatus and around the middle turbinate with sufficient firmness to control bleeding without causing discomfort to the patient.

This is well illustrated in the following case: Mrs. A. M. was 65 years of age and gave a history of having had nasal polypi removed ten years previously with such severe primary and secondary hemorrhages that blood transfusions were necessary. When the polypi recurred she naturally postponed treatment until nasal breathing was completely obstructed. At examination both nostrils were filled with rather fibrous polypi. In view of the history, thorough blood studies were made, but no abnormality was found. The polypi were removed under local anesthesia with snare and appropriate forceps, and both nostrils were firmly packed with absorbable gauze packing. No bleeding followed the operation. The pack was left in place until it completely disintegrated and was expelled by the patient.

The control of bleeding after submucous resection has been a problem since the operation was devised. The fact that no two operators use the same method of control is in itself the best evidence that no satisfactory method has yet been introduced. I have tried many forms of postoperative packs with varying degrees of satisfaction. All of these depend on pressure alone for their hemostatic action and, as a result, discomfort to the patient is usually the rule. Further, none of these packs prevented the slow oozing of blood, which at times assumed hemorrhagic proportions in spite of the fact that the nose was packed with extreme firmness. In almost every case when the pack was removed there was nasal bleeding of varying degree lasting from a few minutes to even a week. This persistent nasal bleeding was always upsetting to the patient and his family. These factors should be seriously considered in the general management of the patient and the physician must not neglect the psychologic management of his patients. A blood-encrusted nose does not send a patient to sleep with any great peace of mind. A submucous resection is a most useful operation. When it is performed well technically and when the patient is managed with esthetic nicety (all postoperative bleeding well controlled) it serves its purpose most effectively.

I employ an L-shaped incision made on the convex side of the deviated septum, with the lower segment being carried well backward. Such an incision permits easier drainage of possible intraseptal bleeding and obviates too firm packing. At the completion of the operation the absorbable gauze strip is introduced into the nostril having the septal incision and carefully packed so that the septal flap is in good position. The other nostril is packed with petrolatum gauze. If there was any reconstruction of the lateral cartilages, some absorbable gauze is also tucked into the nares. Twenty-four hours later the petrolatum gauze is removed, but the absorbable gauze is left in place. The following day as much of the absorbable gauze as possible is removed with forceps and applicators. The remainder is expelled from the nose as any nasal discharge would be expelled. This packing does not produce a foul discharge, regardless of the quantity of absorbable gauze used. To date there have been no postoperative infections.

An illustrative case is that of Mr. J. G. He had a septum moderately deviated to the left, with a large ridge along the left side of the perpendicular plate of the vomer ending in direct contact with the middle turbinate. The septum was also very thick. The nasal mucosa was anesthetized as thoroughly as possible with a 2 per cent solution of tetracaine hydrochloride N. N. R. followed by an application of 1:6,000 solution of epinephrine hydrochloride to produce the greatest possible shrinking and hemostasis during the operation. The anterior

portions of the septum were anesthetized with a 1 per cent solution of procaine hydrochloride. The L-shaped incision was made on the left side of the nasal septum; it was started from above at the mucocutaneous junction and was carried well backward below the level of the septal ridge already noted. All deviated portions of the cartilaginous and bony septum were removed, and, as would be expected in removing the large spur, the left side of the mucosal and periosteal covering of the septum was lacerated. At the completion of the operation the left side of the nostril was carefully packed from above downward and from behind forward with moderate firmness. The right side of the nose was packed with petrolatum gauze, with only moderate firmness. This was just the type of case in which ordinarily there would be postoperative bleeding, but with the absorbable gauze pack in place there was no "dripping" of blood at any time.

A summary of cases in this series is as follows: cases of nasal bleeding 30; cases of polypi 30; cases of submucous resection 60.

COMMENT

The value of oxidized gauze or cotton as noted in various surgical procedures is based on its properties of absorbability and hemostatic action. The possibility of utilizing oxidized cellulose as an aid in the practice of surgery was suggested by Clark to Frantz,[3] who subsequently, in a series of investigations, studied the reactions of oxidized cellulose implanted in tissue and defined its spheres of usefulness.

Absorption occurs between the second and the seventh day following implantation of the dry material, depending on the amount of material used, the adequacy of the blood supplied to the area and the degree of chemical degradation of the implanted material.

Hemostasis depends on the marked affinity of cellulosic acid for hemoglobin. When exposed to blood, either in vitro or under surgical conditions, the oxidized gauze or cotton turns a very dark brown or black and forms a soft gelatinous mass, which readily molds itself to irregular surface contours and controls surgical hemorrhage by acting as a cork in the wound. Since hemorrhage can be controlled only by causing the blood to clot within the mouth of the blood vessel, pressure should be exerted on the gauze or the cotton in order to facilitate the sealing off of the mouths of the bleeding vessels.

Two factors require emphasis: Cellulosic acid does not enter into the physiologic clotting mechanism per se, but forms what might be termed an artificial clot, and therefore is effective in controlling bleeding. The hemostatic action of cellulosic acid is not enhanced by the addition of other hemostatic agents.

SUMMARY AND CONCLUSIONS

The problem of the more common nasal hemorrhages is presented.

The value of oxidized gauze and cotton in the control of these hemorrhages has been established.

Oxidized gauze and cotton have been found effective and safe in intranasal surgical procedures.

151 Livingston Avenue.

3. Frantz, V. K.: New Absorbable Hemostatic Agents, Bull. New York Acad. Med. **22**:102 (Feb.) 1946.

PROGRESS IN OTOLARYNGOLOGY

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

FUNCTIONAL EXAMINATION OF HEARING

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AGAIN, in 1946, the rehabilitation of those handicapped by impairment of hearing and the conservation of hearing make up the subject matter of the greatest number of contributions included in this review. The effect of trauma of the organ of hearing and the proper evaluation and prescription of hearing aids also have attracted much attention. Few additions have been made to functional tests of hearing as such. Newer concepts, as well as a revaluation of these tests, are reported in some of the articles. Available foreign literature is still of scant volume.

TESTS

Tschiassny [1] has written a fine and concise historical review of the tuning fork tests. He starts his review by referring to Ingrassia, who discovered the phenomenon of bone conduction almost four hundred years ago. Bibliographic sketches and pictures of such famous men as Weber, Bonnaport and Rinne are part of the paper. Interesting incidents relative to the various discoveries are related, and a bibliography of the important articles describing fundamental tests, such as the Weber, Rinne and Schwabach tests, is given.

Lierle and Reger [2] report the results of using a special bone conduction vibrator in correlating measurements of bone and air conduction acuity which were made with the audiometer over a wide frequency range, 128 to 8192 cycles per second, with various types of aural lesions. They point out the limitations and difficulties of making such measurements with tuning forks, especially if comparisons of air and bone conduction are made with the same fork. Even when the decrement of

1. Tschiassny, K.: Tuning Fork Tests: Historical Review, Ann. Otol., Rhin. & Laryng. **55**:423 (June) 1946.

2. Lierle, D. M., and Reger, S. N.: Correlations Between Bone and Air Conduction Measurements Over Wide Frequency Ranges in Different Types of Hearing Impairment, Laryngoscope **56**:187 (May) 1946.

the fork has been ascertained and used to determine decibel loss, the findings will be variable. The decrement of a fork is constant only under definite specified conditions. It will vary with the manner in which the fork is held or supported and with the pressure by means of which the fork is held in contact with the skull. Unless accurate methods are employed for obtaining the decrements of forks and unless standardized technics are adopted in the testing procedure, gross errors will result when hearing acuity is determined quantitatively in terms of decibels. Because of these difficulties, a study was made with a new type of electrically activated bone conduction receiver or vibrator designed for use with the audiometer Sonotone type BR-66. This is supposed to be free from variations resulting from variations of the pressure applied when it is held against the head. Stimulation of hearing by air conduction is considerably reduced by a special soft rubber cylinder which is attached to the vibrator, and in addition a special hard band was constructed to hold the vibrator and thus eliminate shifting, changes of pressure, and possible fatigue of the patient. Twenty-one normal patients were first tested to determine normal thresholds for each of the eight frequencies. Special tests were made to show that the vibrator stimulated bone conduction rather than air conduction in the normal ears and that the air conduction and bone conduction differential, which varied from 25 to 15 decibels, was sufficiently great to justify the use of the vibrator in a further study of pathologic hearing. Because of the known difficulties encountered in masking bone-conducted sound, this was not done, to avoid erroneous conclusions. Only bone conduction threshold values of the ear to which all bone-conducted sounds were lateralized were used. A comparison of bone and air conduction acuity measurements obtained with both the audiometer vibrator and the forks on different types of pathologic involvement of the ear revealed the following diagnostic criteria applicable to audiometric measurements. If air conduction acuity is below normal but bone conduction is normal or increased, the patient has a lesion of the middle ear. If air and bone conduction are similarly decreased or there is a disproportionate decrease for bone conduction, the condition is a lesion of the inner ear, especially if a lesion of the middle ear has been ruled out by the history, the physical examination and mobility tests, such as the Gelle and Bing. If both air and bone conduction are decreased with a greater loss by air than by bone, the impairment is due to a combination of lesions. These are presented as broad generalizations.

The writers conclude that the vibrator substantiates findings made with tunings forks but is superior to and more desirable than the forks in several respects. In the testing of bone conduction acuity it enables them to make measurements which can be immediately and directly

compared with those of air conduction. It permits testing bone acuity over wider frequency and greater intensity ranges than can be done satisfactorily with tuning forks. The Rinne and Weber tests give the same information that is obtained with forks, but over wider frequency and intensity ranges. The Gelle, Bing and occlusion tests can be conducted by means of the vibrator with a higher degree of accuracy. Increased bone conduction is a real phenomenon but occurs so rarely that it should be considered the exception rather than the rule. It occurs most often with frequencies below 1500 cycles per second. A patient may exhibit both increased and decreased bone conduction in the same ear—increased with the low frequencies and decreased with the high. Effective masking for bone conduction is more difficult than that for air conduction. Properly constructed and calibrated bone conduction vibrators employed in the right manner possess sufficient reliability and accuracy to justify their use. The development of a vibrator suitable for general use will mark a definite progressive advance in the functional examination of hearing.

MacFarlan [3] describes a practical fatigue test as furnishing an added phenomenon that is diagnostic of many types of nerve deafness. Fatigability of the auditory end organ is prominent and pronounced in deafness due to heavy concussions and less pronounced in the nerve type deafness found in aviators, due to noise and changes of pressure. It is rarely found in cases of simple catarrhal deafness. The test is done by first determining threshold values. The most deafened ear is then exposed to frequencies of either 1024 or 2048 double vibrations at a pitch of loudness 25 decibels above the patient's threshold for three minutes. The hearing threshold for that pitch is then recorded, and the difference between it and the original reading represents fatigue. Retesting over a period of an hour gives the index of recovery, its speed and degree. The carry-over tone memory rarely interferes with the test, and if it should, it can be eliminated by using the sharp cut-off switch. The test is not practical or possible with profoundly deaf ears, since not enough hearing remains to permit these organs to be exposed to a fatiguing intensity. Two cases are reported to show how this test may be applied to substantiate a diagnosis of uncomplicated nerve deafness.

Froeschels [4] stresses the great importance of examining the hearing status of the suspected hard of hearing child as early in life as possible. Normal development of speech is dependent on the acoustic centers' being reached and trained by acoustic stimuli. Their stimulation is the impetus necessary for the development of spontaneous speech. For

3. MacFarlan, D.: Fatigue Test and Its Significance, Arch. Otolaryng. **44:** 334 (Sept.) 1946.

4. Froeschels, E.: Testing the Hearing of Young Children, Arch. Otolaryng. **43:**93 (Feb.) 1946.

testing very young children the audiometer is not satisfactory, because it requires active cooperation on the part of the patient. Froeschels prefers a "direct tone introduction method," for which he employs a set of whistles from Urbantschit's organon, the tones ranging from F1 to F4. Each tone is delivered directly into the ear through a rubber tube having an olive tip on one end, which is inserted into the external canal, while the other end of the tube touches the opening of the whistle through which the tone escapes. The olive tip should be covered with fine rubber to prevent the stream of air from entering the ear. The reflexes accepted as positive responses are blinking, grimaces, smiling and the "eye muscle reflex."

The "eye muscle reflex" was described by Froeschels in 1926. When with a whistle and an uncovered olive tip a tone is introduced into the external auditory meatus, a slight swaying of the body occurs, associated with a horizontal and occasionally a vertical jerking of the eyeballs in a direction away from the source of the sound, followed by an accelerated moving back to the initial position. The test has been done on over 100 patients with positive results and with the definite response that the patient heard the tone in each case. None of these patients, on the other hand, showed a positive reaction on compression or aspiration of the air of the external auditory canal (fistula test). The whistle test is concerned entirely with reflexes and does not require the cooperation of the patient. Although the response does not necessarily indicate hearing of a single note, as it may be due to hearing the overtones, positive reactions to different whistles should indicate hearing for different tones, as each whistle has different overtones. If there are positive answers to almost all of the whistles, hearing throughout the whole range of whistles is probably present. This test has been done on hundreds of children of ages 3 and over. The hearing of an infant of 15 months was examined, and the case is reported in detail. The author suggests that residual hearing should be stimulated and utilized very early by repeated introduction of those sounds which are heard through a hearing tube. Later musical sounds, noises and speech sounds should be used, and at a more advanced state, phrases and a system of sounds. In this manner, spontaneous development of speech could be brought about in some of these unfortunate children.

Mygind [5] states that the old rule that conduction deafness is characterized by preponderant loss of hearing for low tones and perception deafness by loss for high tones applies only to tuning forks and monochord. In audiometry this rule does not apply. The audiogram of the case of severe otosclerosis, for instance, forms a horizontal line. In cases of mild otosclerosis and of tubal catarrh the graph may decline

5. Mygind, S. H.: Some Orienting Remarks on Tuning Forks and Audiometer and on the Registration of Defects of Hearing, Acta oto-laryng. **33**:1, 1945.

to the right, suggestive of perception deafness. The relation between the physical energy of the source of the sound and the biologic loudness of the sound as perceived is not the same for all frequencies. In radio the same amplifier cannot be used for bass and treble. Low sounds may be shut out by putting fingers in the ears, but not high ones. With the same energy, subjective loudness is twenty times greater at 50 cycles than at 1,000. At lower frequencies this disproportion is greater. The same number of decibels may correspond to widely different values so far as subjective loudness is concerned. To measure a hearing defect in decibels is misleading.

On the basis of the Fletcher-Munson equal loudness curves, decibels may be converted into sons, the biologic measurement required. In this way audiograms are obtained which are in harmony with the results of tests made with tuning forks, as well as with the sensations of the patient. Both forks and audiometer have their drawbacks and advantages, so that neither can be done away with.

Sparrevohn [6] evaluates the degree of "carry over" from the good ear to the poor one. The number of decibels lost by sounds passing through the cranium varies with different frequencies. The author has established a limit in the difference between air conduction audiograms of the two ears within which the poorer ear may be said to be functioning, and another limit outside of which the ear is probably deaf. Sounds lose only inconsiderably in passing through the bones of the cranium; the loss may be zero. The masking effect of M. P. Pederson's masker at 90 degrees is rather small. The cross-masking effect of Bárány's noise apparatus is considerable, and highest at the frequencies of the spoken voice and the whisper. His material was 8 men and 5 women between 27 and 64 years; 12 had undergone labyrinthectomy; 1 had a destructive type of postoperative labyrinthitis, with total loss of acoustic and vestibular function.

Provided that there is no conduction deafness in the good ear and that the difference in air conduction in the two ears does not exceed 25, 25, 40, 50, 52, 46, 42, 45 and 40 decibels from the low to the high frequencies, respectively, there is hearing in the poorer ear. If the difference is above 50, 50, 60, 85, 85, 72, 88, 88, 70 and 70 decibels from the low to the high frequencies, there is every probability that there is no hearing in the poorer ear. The masking should correspond accordingly.

A comparative study of the thresholds of hearing recorded when one and when both ears were tested was made by Caussé and Chavasse.[7]

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6. Sparrevohn, U. R.: Some Audiometric Investigations of Monaurally Deaf Persons, Acta oto-laryng. **34**:1 (Jan.-Feb.) 1946.

7. Caussé, R., and Chavasse, P.: Recherches sur le seuil de l'audition binauriculaire comparé au seuil mono-auriculaire, Compt. rend. Soc. de biol. **135**:1272 (Oct.) 1941.

They use a special apparatus having an electric foot pedal by which the subject could signal, as well as 20 trained young observers, in a soundproof room. They comment that there has been relatively little written on the subject and that there has been disagreement among the observers. In their study they used only three testing frequencies: 500, 1000 and 1500 double vibrations. Seven hundred and eighty-seven tests were made. Their work showed that for the three frequencies there is a definite difference between the monaural and the binaural threshold of a little less than 3 decibels. This difference is more pronounced when one passes from silence to sound than from sound to silence. The right and left ears behave in identical fashion, contrary to the statement of Weinber and Fischgold that the left threshold is better than the right one. The differences observed with frequencies of 500 and 1000 imply a perfect summation of the energies received by each ear to give a binaural threshold; for a frequency of 1500 the summation is imperfect.

A summary of audiometric findings in various disturbances of hearing is given by Netto.[8] There are preliminary remarks on the necessity of a "perfectly silent room" and the value of audiometry not only in determining the efficacy of treatment but in diagnosing the early phases of hearing impairment before much difficulty is noted in carrying on a conversation. Thirteen main types of defects are listed: hypoacusis of transmission, hypoacusis of perception, otosclerosis, mixed otosclerosis, syphilitic hypoacusis, senile hypoacusis, occupational hypoacusis, aviation hypoacusis, Ménière's syndrome, chronic progressive deafness, toxic neuritic hypoacusis, hereditary deafness and mixed deafness. These impairments are described in detail, and the descriptions generally correspond to the concepts held in the United States, but some remarks are of interest. The author states that tuberculosis of the ear gives an impairment of air conduction of low tones with normal bone conduction; that high tone impairment due to acute tubal obstruction will present the picture of conduction deafness if the examination is limited to tuning fork tests; high tone impairment of tubal origin, whether acute or chronic, is considered to be due to lymphoid granulations obstructing the mouth of the eustachian tube and gives a good prognosis when properly treated. Syphilitic deafness is often characterized by a rapid drop at the frequencies 4096 and 8192, but a general reduction is often found as well; bismuth therapy, preceded by injections of pilocarpine hydrochloride, is of value in this condition. Senile deafness begins with diminution of hearing for tones above 2048 double vibrations at 50 years of age; hearing of 1024 double vibrations stays normal up to the age of 70, and 512 is the last frequency to be involved; a loss of over 40 double vibrations in the high tones indicates atrophy of the

8. Netto, O. C.: Audiometric Interpretation of Hypoacusis, Brasil med. **59**: 398 (Nov. 17-24) 1945.

organ of Corti. The article appeared in a Brazilian biweekly journal of medicine and surgery, which may be the reason that neither case reports nor audiograms are given.

Mozota [9] mentions briefly the tests of hearing which were used in the past and states that audiometry has come to occupy the leading position among methods of testing hearing, this fact being recognized by the Spanish state which has equipped its clinics with this apparatus (Sonotone model). The ways in which the audiometer may be used in teaching, in estimating disability, in determining the hearing of deaf-mutes, in deciding for or against operations and in determining the progress of aural diseases are fully explained. The author stresses its value in checking the claims concerning hearing aids and deplores the fact that in Spain there is no organization such as the Council on Physical Medicine of the American Medical Association which checks the claims of manufacturers in the United States. The bel and the decibel are explained; the phon, used on the continent, is stated to be practically identical with the decibel. The construction of the audiogram is explained in terms of the Weber-Fechner law. Bone conduction tests are made with the bone oscillator. Percentage figures are estimated in terms of all the frequencies.

Harris [10] makes a careful analysis of the results obtained with the free voice and the pure tone audiometer in routine testing, in order to determine whether these means are equivalent in the measuring of threshold acuity and whether under carefully controlled conditions the test with one may be more reliable and more efficient, and finally, if the two means are of equal reliability, which should be used to fit best the purposes of a particular activity. He analyzes carefully most of the studies made by other observers, as well as his own, and confirms the consensus that the results of a careful voice test and pure tone audiometry carried through the speech range (512 to 2048 cycles per second) are intimately convertible and disclose about the same amounts of auditory function. A comparison of six studies reveals the relationship between the two tests to be a straight line function. These conclusions are based largely on laboratory conditions. He then considers the reliability of these tests when taken out of the laboratory and placed in hands of routine testers under inferior and unsupervised test conditions. An analysis of recent studies shows that routine audiometry can well be expected to be accurate to within 5 decibels. For near normal subjects measurements obtained with the whispered voice should be as accurate. A check of 5,248 ears with the whispered voice and by a

9. Mozota, J. R.: Value of Audiometry, An. casa de salud. Valdecilla **8**:118, 1945.

10. Harris, J. D.: Free Voice and Pure Tone Audiometer for Routine Testing of Auditory Acuity, Arch. Otolaryng. **44**:452 (Oct.) 1946.

careful six octave audiometric test given routinely to all candidates for submarine service over a three month period showed that only 92 ears considered normal after whisper testing had an average loss of 15 or more decibels. This average loss should correspond to a loss of several feet on an ideal voice test and represents 1.75 per cent as an index of the error of selection of the voice test. To determine normal distance for two types of phonetic material and three types of test rooms, an experiment was undertaken in which five pharmacist's mates were used as testers together with 13 enlisted men who had normal audiograms. Tests were made in a soundproof room, a classroom and outdoors. When digits were used, the test and the retest mean were 14.6 and 15.6 feet in the classroom, 16.1 and 15.8 feet for the soundproof room, and 14.3 feet for outdoors. For the spondee list the variation was from 14.9 to 14.2 feet. One can conclude that a distance of 15 feet (4.5 meters) can be depended on to be a fairly accurate normal distance for the whispered voice tests, regardless of the acoustics of the room and the level of noise. A novel method was used for measuring decay of sound as a function of distance. A loud speaker was set up 15 feet from a normally hearing ear, and discreet words were presented by means of a phonograph recording. An attenuation pad graduated in decibel steps was inserted between the phonographic output and the loud speaker. Percentages of intelligibility were determined for several attenuation readings, and the psychophysical function was drawn, relating present intelligibility to attenuation reading. From this the attenuation reading corresponding to 75 per cent intelligibility was determined. The same procedure was repeated, with the loud speaker being moved to 13 feet, 11 feet, and in graded steps up to 6 inches (4 meters, 3 meters and 152 cm., respectively). The difference found in the decay of sound between the free field and the soundproof room was never greater than 4 decibels at any distance. The data obtained in the narrow test alley showed a greater variation. This type of test room, namely, the narrow reflective alley, 26 by 5 by 9¼ feet (8 by 1.5 by 3 meters), is almost useless for acuity testing. An analysis of the vocal intensities necessary for an effective free voice test, based on Fowler's work, reveals that accurate placing of the voice at intensities from a low whisper to a loud shout is beyond the ability of any but the most experienced tester. One could not expect any reliability of such a test carried out by routine testing personnel. For a population of near normal acuity a whispered voice test could be used adequately in a fairly nonreflective room, but for seriously deafened people an additional variable, that of intensity of voice, would have to be added to that of distance.

In determining testing time for the procedures, Harris reports that one needs an average of four and a half minutes to perform a 6 octave audiometric test on the two ears of a person of average or better intel-

ligence and near normal acuity of hearing, using the technic of crossing each threshold at least twice before making the final reading. The two ears of the same type of subject can be tested with the whispered voice in thirty-four seconds. This is a big factor when large numbers of persons are to be tested in a short period. In determining the relative applicability of these two tests, various conditions and circumstances must be considered. For complete clinical analysis and for fitting hearing aids, both speech and pure tone testing must be done. For certain job requirements, only an extended frequency range, pure tone audiogram would be necessary. For the vast majority of persons undergoing acuity testing as screening for the Armed Services, the Veterans Administration, civil aviation or industry, of whom only a fair ability to hear human speech is required, only one test is necessary; the type depends on which can be done most efficiently and reliably. If audiometry is individual, the free voice test is quicker, and under proper conditions and with careful supervision it can be made almost as satisfactory as audiometry for screening of a near normal population. If, on the other hand, audiometry is modified for a screening procedure or for group testing, it can be as rapid as the free voice test and give possibly more valuable information. For a population suffering generally from defective hearing, audiometry is superior and should be mandatory.

Carhart[11] investigated individual differences in relative acuity of speech reception and pure tone reception, in an attempt to clarify the incidence and the significance of these individual differences. Test results were obtained from the Aural Rehabilitation Program of Deshon General Hospital. Pure tone thresholds were obtained with the commercial audiometers, and speech reception thresholds were determined with the Harvard by-syllabic words and the monitored live voice. The "better ear" average for 512 to 2048 cycles per second was taken as the criterion of acuity for pure tones. Although there was a high interdependence between the average threshold for 512 to 2048 cycles per second and the speech reception threshold, individual patterns often showed sharp discrepancies between the two. The difference scores were obtained by subtracting the average for 512 to 2048 cycles per second from the speech reception threshold. He found that "(1) most patients showed thresholds for speech which were close to their better ear average for 512 to 2048 cycles per second; (2) a slight majority had better pure tone averages than speech reception thresholds; (3) extreme difference scores of 25 decibels or more were observed in both directions; (4) extreme discrepancies tended to be a little more frequent and marked when acuity for speech reception was better than acuity for pure tones."

11. Carhart, R.: Individual Differences in Hearing for Speech, Ann. Otol., Rhin. & Laryng. **55**:233 (June) 1946.

Although audiometric patterns may deviate widely without appreciable effect, it was found that certain types of pattern alter the relation between acuity for pure tones and that for speech reception, accounting for the wide range of difference scores in heterogeneous groups. Persons with high tone loss more specifically tended to have speech reception scores superior to their averages for 512 to 2048 cycles per second. Homogeneous groups having flat losses, losses with notches beyond 2048 cycles per second and atypical audiometric patterns showed a loss for speech reception which equaled the average for 512 to 2048 cycles per second. Persons whose loss of hearing was recent, i. e., present for less than two years, yielded speech reception thresholds 4 decibels better than the averages for 512 to 2048 cycles per second, whereas older persons showed no systematic discrepancy between the two measures of auditory acuity. Difference scores did not appear to be definitely related to either perceptive or conductive types of impairment. Investigation of persons presenting acoustic trauma and deafness due to blast as a segregated group yielded contradictory results. The contradictions may be due to selective factors which tend to load trauma groups with persons who from others causes than the trauma have better acuity for speech than for pure tones. In general, several variables produce systematic shifts in difference score distributions. A portion of the paper is devoted to an analysis of case histories and a clinical interpretation of discrepancies between the acuity for pure tones and that for speech. Some of the difference might be due to: impairment of higher neural centers; a pattern of pure tone loss favoring displacement of the speech reception score; unreliability of the patient's response; deficiencies of vocabulary and perception resulting from loss of hearing at birth or at an early age; insufficient mastery of English; malingering; psychogenic involvement. The combined use of both pure tone audiometry and speech reception technic adds important information to help one evaluate the reliability of test results, the credibility and variability of the patient's loss, the referral which may be required and the rehabilitation procedures which may be indicated.

Aberg [12] presents an instrument for unmasking shammed unilateral deafness. This instrument consists of a double telephone to be used as an adjunct of the audiometer. The ear pieces are fed with two tones from the audiometer, a pure and an impure (masking) tone. A diagram on the switch identifies the tone used in each ear. By turning the switch the tone in the right ear piece can be shifted to the left ear piece and that in the left ear piece to the right, interchangeably, each ear piece carrying

12. Aberg, H. K.: The Demaskator, an Instrument for Unmasking Shammed Unilateral Deafness, Acta oto-laryng. **33**:425 (Dec.) 1945.

only one of the sounds at a time. The elements of surprise and confusion are fundamental features.

A comprehensive treatise on audiometry, contributed by de Rezende Barbosa,[13] appears as a monograph comprising two numbers of the *Brazilian Review of Oto-Rino-Laryngology*. It consists of more than 150 pages under chapter headings indicating the following topics: historical considerations, including the various models and the steps which led to the modern machines; basic principles of audiometry; audiometers (the ones used by the author were the Western Electric Model 6A and the Sonotone Model 2) and the technic of making the tests; the material used by the author in his studies (1,238 audiograms made for 619 persons over a period of five years, normal audiograms, audiograms of the three classes of hypoacusis—conduction, perception and mixed deafness); conduction deafness; perception deafness; mixed types of deafness; conclusions; bibliography.

The author has borrowed freely from Bunch and other leading American writers, as well as from a number of European otologists, interpolating their views and audiograms with his own case reports to produce a remarkably up-to-date and well documented study. All the modern audiometers, including the German Oto-audion, as well as Lennart Holmgren's recent audiometer, are described; it is interesting to note a picture and mention of a recent Argentine model with a range of 16 to 20,000 double vibrations. The German, French and American types of audiograms are shown and explained, as well as the steps that led to the origin of the American types. The importance of soundproof rooms and of noise levels is stressed, and authorities are quoted on this point in considerable detail. A diagram of the acoustic room of the otorhinolaryngologic department of the Naval Aviation Service at Rio de Janeiro seems to offer some novel features. Other possible sources of error on the part of the apparatus and on that of the examiner are thoroughly discussed.

The chapter on the normal audiogram and its physiologic variations includes, besides the conclusions and diagrams of American authorities, a summary of the work of the Carnevale-Ricci of Milan, Italy. This paper, published in May 1939, is based on a study of 80 persons ranging in age from 50 to 96 years and is interesting in that the author finds that not only high tones but low ones as well become less audible with advancing age, so that between 85 and 90 years the tones best perceived are in order: 1024, 512 and 256 double vibrations.

Barbosa's own material is well classified as to age, occupations and etiologic diseases. The last include a number of the more unusual

13. Barbosa, J. E. deR.: Audiometria clinica, Rev. brasil. de oto-rino-laryng. (supp.) **14**:67 (March-April-May-June) 1946.

conditions, such as congenital atresias (both preoperative and postoperative audiograms were made), neuritides of various types, electric shock, endocrine disorders and tumors of the brain. Twenty-two cases of neurosyphilis are among those examined. Numerous audiograms are given, as well as comment, which follows along the lines commonly accepted in the United States. The author concludes that audiometry is the most valuable of all acoumetric methods available to the otologist.

Carhart [14] reports the system of classifying audiograms to meet the need of the acoustic clinic of Deshon General Hospital. The aim was to achieve a coding procedure which would be inclusive in its scope and universal in its application. The main feature of the system is that it defines a small number of basic types of curves such as flat curve, gradual downward slope, marked downward slope, rising curve and the trough. Each of these takes as its code letter the first letter of the first word: F for flat curve, G for the gradual downward slope, and so on. The severity of the loss is represented by the number where the "curve of best fit" intersects the axis for 1024 cycles per second. This is often the threshold obtained at 1024 cycles per second. The "curve of best fit" is the ideal curve for each basic type, and any audiogram which falls within 10 decibels of this curve is placed in that category. If then the "curve of best fit" crosses 1024 at 50 decibels, the number 50 is used with the code letter. Modifying characteristics, such as general irregularities and special deviations, are indicated by modifier symbols appropriately placed before or after the symbol of the major category. The position and the magnitude of each deviation is represented by appropriate subscripts and superscripts attached to the notation symbolizing the deviation.

A transparency was developed which can be placed over the audiometric chart so that the code notation can be easily determined and the rules of the system quickly applied. A transparency is recommended for those who are to employ the Deshon classification system, as it simplifies greatly the mental computations and the making of necessary divisions for adequate coding.

Wright,[15] in his presidential address, before the Royal Society of Medicine, states that the cochlear lesion of Ménière's disease precedes the vestibular, often for a long period. The clinical picture is one of tinnitus and progressive deafness, usually unilateral. These are often accompanied by hyperacusis and paracusis. The impairment is of the perceptive type, and fork tests may be misleading if masking of the better ear is not done. There is a sense of fulness in the affected ear, and inflation

14. Carhart, R.: An Improved Method for Classifying Audiograms, Laryngoscope **55**:640 (Nov.) 1945.

15. Wright, A. J.: Cochlear Deafness, Proc. Roy. Soc. Med. **39**:265 (March 1946).

may produce a short-lived improvement of hearing, which may lead to a mistaken diagnosis of middle ear defect.

Foght [16] finds the Fowler recruitment phenomenon present in this syndrome, indicating, as described by Fowler, an inner ear deafness.

Hansen [17] placed the healthy subject on a tilting table and held the subject head down at 30 to 45 degrees for one to fifteen minutes. Bone conduction was taken by way of the teeth, as the skin of the scalp and the region of the mastoid process becomes edematous. Eleven subjects 11 to 55 years of age were tested. The tests were made prior to, during and after tilting. The hearing time for the fork was shortened 10 to 15 per cent by both bone and air; the low limit was heightened to 24 double vibrations; the high limit was unchanged. Older persons reacted more strongly than young. Ocular examination showed no evidence of an increase of intracranial pressure, and the author attributes the change to increased intralabyrinthine pressure.

Some increase of intraocular tension was shown in glaucomatous patients. Two patients suddenly tilted to normal showed spontaneous nystagmus.

Martin [18] discusses the value of narcosynthesis used in the diagnosis and treatment of psychogenic deafness. Thirty-eight per cent of all patients admitted to Hoff General Hospital because of "blast deafness" were found to have pure psychogenic deafness or organic with a large functional overlay. Of 75 deaf patients studied under sodium pentothal, 12 per cent were found to have psychogenic deafness. The largest group of patients selected had deafness not associated with combat. Complete cooperation of the otologist, the psychiatrist and the psychologist is desirable for the careful selection of patients and the ones to be treated by narcosynthesis. A simple test for screening all those with deafness due to psychosomatic factors would be desirable, and the possibility is being explored through the use of the conditioned reflex pathways of sound. The test consists in producing narcosis with sodium pentothal, injected intravenously, after several previous interviews, during which the patient, through intense suggestion, is convinced, if possible, that he will hear normally. The patient is kept in a "babbling narcotic state," during which he is asked simple questions and is assured that he is now able to hear normally again. The external ear is then sprayed with ethyl chloride to produce a definite change in its temperature, and the patient is assured that his hearing has returned. As

16. Foght, E.: Remarks About the Acoustic Findings in Ménière's Syndrome, Acta oto-laryng., 1944, supp. 51, p. 230.

17. Hansen, J. F.: Acoustic Vestibular Examination of Healthy Persons During Rocking Experiments, Acta oto-laryng., 1944, supp. 51, p. 240.

18. Martin, N. A.: Psychogenic Deafness, Ann. Otol., Rhin. & Laryng. **55**: 81 (March) 1946.

the patient answers questions during the test, one ear at a time is blocked and the other ear tested. This procedure takes approximately twenty minutes, but the patient is observed continuously for the next hour or two. Following this, complete audiometric tests and spoken and whispered voice tests are made. The tests are repeated the following day and as often thereafter as necessary. If there is any question of the results of the live voice tests, recorded speech perception tests are made as a further determination of the threshold of hearing. Although this is not a foolproof method of diagnosing cases of psychogenic deafness, it has proved itself a highly useful one, yielding much information not obtainable by the accepted otologic methods of examination.

Jellinek [19] discusses the effects of psychosomatic factors of hearing. She shows how various psychologic states can influence acoustic behavior. Thinking of pleasant things, for example, may produce an increase of response of 5 decibels or more for some frequencies as compared with the response observed in a previous audiometric examination. The reverse may also occur if troublesome or irritating thoughts enter the picture. Vestibular influences, such as changing the position of the head, may also influence hearing in some persons. Similar changes are observed with variations of visual perception, with different colored lights, with continued closure of the eyes and with increased respiratory function. The response which a person makes to the sound world is a complex phenomenon, which consists not only of passive reception but also of active acceptance and integration. Integration of the hearing experience can be increased by cheerful acceptance of sound and by directing greater attention to the source of sound. These factors offer a possibility for a therapeutic technic. Methods are now being worked on whereby the physical and the mental attitude of the patient may be influenced so that he will use all the hearing he has left effectively.

Thiebaut, Lemoyne and Wolinetz [20] report a case of word deafness following an apoplectic stroke in a woman of 50. The patient was seen about a year after the onset of her deafness, which had not improved but was somewhat compensated for by lip reading. Examination showed a psychic type of deafness, with ability to speak and write correctly but with inability to understand what was said. This included not only conversation but other sounds, such as music. She could no longer play even a scale on the violin but could sing childhood tunes. Although formerly reliable, she could no longer perform even

19. Jellinek, A.: Psychosomatic Factors in Hearing, J. Clin. Psychopath. **7**: 599 (Jan.) 1946.

20. Thiebaut, F.; Lemoyne, J., and Wolinetz, E.: Surdité verbale avec hypoacousie bilatérale étudiée par l'audiomètre, Rev. neurol. **76**:93 (March-April) 1944.

the least complicated task. There was bilateral hypoacusis. With tuning forks, the Rinne test was negative, air conduction considerably diminished, bone conduction normal, the Weber test sound lateralized to the better ear, the Gellé test negative. The audiogram (Sonotone audiometer) showed a reduction of 60 to 70 decibels in air conduction and little diminution in bone conduction. Absolute and relative bone conduction were nearly equal. The authors explain the psychic deafness on the basis of softening in the left temporal lobe. As central deafness requires a bilateral lesion, they believe that the patient already had a latent involvement of the right temporal lobe when the hemorrhage occurred on the left side. They are unable to explain the good bone conduction except on the theory that this function is less highly differentiated than hearing by air conduction.

Complete bilateral destruction of the sylvian, ectosylvian and strips of the coronal and suprasylvian gyri of 3 dogs prevented reappearance of correct auditory conditioned differential responses in 1,100 tests and in additional tests six months later.[21]

In 1 dog superficial coagulation of these areas caused only delayed return of the correct responses.

In only 14 of 1,000 consecutive patients with bilateral deafness observed by Howard [22] at the United States Naval Hospital in Philadelphia was this condition solely or predominantly due to drug therapy. In 12 it was due to quinine, and in 2, to salicylates. Quinine is the drug most often responsible, producing permanent deafness when the basic coil of the cochlea is damaged. One gram of quinine taken on each of two successive days at weekly intervals over a period of three weeks produces a decrease of 20 decibels in the conversational range. Three-tenths grams taken daily for four weeks will temporarily decrease auditory sensitivity. If the use of the drug is prolonged, the decrease may become permanent. Ears which have already shown a perceptive loss due to gunfire or other aural trauma are more susceptible. Large doses of quinacrine hydrochloride ("atabrine") had no effect on the hearing. Quinidine, however, is slightly more toxic to the auditory mechanism than quinine. The salicylates are the second most frequent offenders. Drug deafness is characterized by a perceptive type of hearing involvement, affecting first the high tones and later the conversational range, producing a flattened curve. The bone conduction time is shortened. When tinnitus is present, medications such as quinine and salicylates should be avoided or given cautiously.

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21. Allen, W. F.: Effect of Destroying Three Localized Cerebral Cortical Areas for Sound on Correct Conditional Reflex Differential Responses of the Dog's Foreleg, Am. J. Physiol. **144**:415 (Aug.) 1945.

22. Howard, J. C., Jr.: Auditory Impairment Caused by Drugs, U. S. Nav. M. Bull. **46**:387 (March) 1946.

CONSERVATION AND REHABILITATION

Coates,[23] addressing the American Academy of Ophthalmology and Otolaryngology as guest of honor, speaks of deafness and the rehabilitation of those afflicted with it as constituting one of the important problems and works of the Academy. He mentions the programs of the clinics developed by the Armed Forces during the war and suggests how such successful programs can be put into practice by otologists in civil life. The establishment of clinics using university or hospital facilities where possible, to which patients can be referred by otologists, is one way of accomplishing this. The operating cost should be covered by proper fees except in the case of the indigent. Proper equipment, hearing aids and adequate personnel are necessary. The staff should consist of one or more otologists, trained technicians, a psychiatrist, a lip-reading or speech-reading instructor, a speech correctionist and if necessary, an electronic engineer. The patient would go through a regular examination and training similar to that practiced in the rehabilitation clinics in the service. Where this cannot be done, the otologist should acquaint himself with the proper procedures and the plan suggested by the Committee on Conservation of Hearing so that he can give his patient the best treatment and advice with the limited facilities available. The special courses offered by the Academy should be taken advantage of by all, and whatever additional training can be obtained should be utilized, so that all can put this important work on a sound practical foundation.

Lederer[24] and his associates report the program of hearing and speech rehabilitation as it was developed and carried out for the Navy, the Marine Corps and the Coast Guard at the United States Naval Hospital in Philadelphia. Up to an early date in 1946, almost 3,000 patients had been processed at this center. The goal was to teach each one speech reading, fit him with a hearing aid, and train him to use it efficiently, so that he could enjoy a complete, full, economically and socially sufficient life in a normal hearing world. He was also to be educated with respect to the problems of his handicap and taught how to meet these problems intelligently. He was to be taught to live with his disability without being handicapped.

A highly skilled and specially trained staff was obtained. The program was developed with few preconceived ideas. The military hearing tests used were found to be unscientific and inadequate. The greatest reliance was placed on the use of tuning forks, audiometry and

23. Coates, G. M.: Two Problems: Care of the Deafened and Rhinoplastic Surgery, Tr. Am. Acad. Ophth. **51**:11 (Sept.-Oct.) 1946.

24. Lederer, F. L.: Hearing and Speech Rehabilitation: History and Development of the Program, U. S. Nav. M. Bull., March 1946, supp., p. 183.

the use of an electronic evaluator of speech reception. The program also taught a great deal about the performance of various hearing aids. Only those aids were used which met the minimum requirements set up by the Council on Physical Medicine of the American Medical Association.

Koepp-Baker [25] discusses the philosophy and the general approach to hearing rehabilitation. The significance of a hearing loss is known only when it is considered in terms of the total personality of the patient. The significance is measured more by the effect the impairment has on personal adjustments than by the actual number of decibels lost. The patient was made cognizant of the fact that his hearing loss was permanent, at times progressive and not amenable to medical or surgical therapy. By discussing and explaining all this individually or in class work, it was possible to acclimate the patient to his problems and help him overcome personal feelings of insecurity which might result at the realization of his affliction. Each stage of the rehabilitation process is set to make the patient aware of the fact that he is a relatively normal man and must find ways to evidence that he is a successful deafened man. The process of rehabilitation tries to take each man to the point from which he can go on successfully by himself. This requires treating the whole personality.

Processing of aural rehabilitees includes the recording of a complete history and an examination.[26] Hearing tests include conversational and whispered voice tests, Rinne and Weber tuning fork tests and special tests when malingering is suspected. Repeated audiometric checks, as well as the Stenger and Lombard tests, are the procedures normally employed in such cases. Audiometric tests, both for hearing of discrete frequencies and for speech reception, are carried out in the acoustic laboratory. Hearing of discrete frequencies is tested over a 6 octave range. The speech reception tests are made with a special evaluator, capable of determining the perception of normal speech to an accuracy of 1 decibel.

The patient is put through a series of interviews and meetings designed to facilitate the rehabilitative process. Every effort is made to learn the patient's attitude toward his disability and his attitude regarding a hearing aid. The program is then explained to him in detail through individual interviews and group lectures. Medicosocial workers acquaint him with the physical facilities of the hospital and interview him regarding his family relationships and other matters. When a hearing aid is indicated, a plastic ear mold is made for the

25. Koepp-Baker, H.: The Philosophy of, and General Approach to Hearing Rehabilitation, U. S. Nav. M. Bull., March 1946, supp., p. 191.

26. Lederer, F. L.; Harkins, W. B., and Hardy, W. G.: Processing Aural Rehabilitees: Coordination by Medical and Non-Medical Services, U. S. Nav. M. Bull., March 1946, supp., p. 202.

patient. The final preparatory process consists of a speech-reading test to ascertain each person's capabilities as a lip reader, for proper grouping in classes. Following this, the normal reeducational process includes training in the reading of speech, instruction in the optimal use of residual hearing with a hearing aid, individual fitting of an aid, and both group and individual counseling on problems of hearing psychology and adjustment. This program occupied a period of four weeks.

Koepp-Baker [27] describes the physical facilities of the acoustic buildings and laboratory used for the program. He gives a detailed description of the construction of this specially designed acoustic clinic and reeducational center consisting of several soundproof rooms for audiometry, auditory training and speech reading. Special electroacoustic equipment is used. The main instrument is a hearing aid evaluator developed at the Central Institute for the Deaf, in St. Louis, by the Office of Scientific Research and Development of the National Research Council. It is an assembly of a two channel electroacoustic system of high fidelity. The first channel carries speech, pure tone signals or other types of signal material to the subjects in the soundproof rooms. The second channel is used for "talk back" from the subject to the operator, for monitoring, and for measuring sound levels in a sound-conditioned test chamber. Acoustic signals are produced by a resistance tune oscillator, a phonograph turntable, a microphone for live voice and a special noise generator which produces a mixture of all frequencies within the hearing range. The acoustic signals reach the patient either through binaural ear phones or through the speaker. This instrument was designed to make possible adequate measuring of the impairment of the auditory function, to evaluate objectively the compensation afforded by a hearing aid for such an impairment, and to assist in the selecting of the best hearing aid for the patient.

Auditory training equipment requires special amplifiers, high fidelity ear phones and a specially designed turntable. Each auditory training room and lecture room is equipped with a broadcast type microphone flat to 9000 cycles with matching elements for use with input channels of the amplifier. The speech reading rooms also have special amplifiers and high fidelity ear phones, plugged into jackboxes attached to the chairs. For speech correction, 6 magnetic tape records and 6 portable record players with modified amplifiers, jackboxes and ear phones were used.

Eva Thompson [28] describes the methods employed in the selection and fitting of hearing aids in this hearing rehabilitation program of

27. Koepp-Baker, H.: Physical Facilities and Equipment for the Rehabilitation of Hearing, U. S. Nav. M. Bull., March 1946, supp., p. 210.

28. Thompson, E. A.: Testing of Hearing and Fitting of Hearing Aids, U. S. Nav. M. Bull., March 1946, supp., p. 216.

the Navy. The selection and fitting of hearing aids is a complex operation requiring excellent equipment and experienced personnel. The patient's hearing is not changed by a hearing aid, which merely amplifies the sound reaching the ear. Few deafened persons have so little residual hearing that they cannot use an aid. Accurate testing is essential for the proper selection and fitting of an aid. Essential information is obtained from the so-called speech reception test as well as from the audiometric tests. Tests should be made in a soundproof or sound-treated room. The audiometric determinations should be made by an intelligent trained operator who is able to vary the standard technic according to the requirements of each test situation. The test is usually started at 1024 cycles and at a comfortable level, which is approximately 20 decibels louder than the patient's estimated threshold. This frequency is used first because there is less variation in the response to this tone than to the upper or the lower tones. The faintest intensity which can be heard is determined, and the procedure is repeated for each frequency. When bone conduction tests are indicated, a properly calibrated masking noise should be used with all tests. If there is a difference of 30 decibels or more in hearing by air conduction in the two ears, masking should be used also for the air conduction tests. If simulation of deafness is suspected, tests for malingering, such as the Stenger or the Lombard, should be done.

The speech reception test is an accepted means for determining a person's ability to hear and understand speech. It is also used for the evaluation of hearing aids. It can be given with a loud speaker or an ear phone, in testing either unilateral or bilateral hearing, in quiet or in the presence of noise, with or without a hearing aid. One may employ monitored spoken voice, known as live voice, or recorded voice. The test material may include all types of speech. This test is absolutely essential for the proper fitting of a hearing aid. The electroacoustic apparatus consists of an amplifier, a power supply microphone, a decibel meter, a loud speaker and a receiver. This unit was placed in a quiet room or booth separated by a glass panel from a soundproof room in which the patient is seated and which contains a loud speaker and a receiver. There is a communicating system between the testing room and the control room. The patient is seated at a fixed distance from the loud speaker. The operator controls his speech by maintaining the decibel or volume unit meter at a constant level, varying it by adjusting the attenuator. The intensity may be changed in 1 decibel steps over a range of 100 decibels. The speech is first presented at a level at which it is readily understood and then is gradually reduced in intensity until the threshold is established. This threshold is the subject's speech reception level. The test is accurate within 1 or 2 decibels as long as the speech is properly monitored by means of the decibel meter. There

is no appreciable difference whether the voice is that of a man or that of a woman. The test is an important one from the standpoint of the patients because they realize that they are able to hear and clearly understand spoken voice through the amplifying system. This is their first adjustment to the use of a hearing aid.

Also discussed are hearing aids and the method used for properly fitting them. The vacuum tube type is far superior to the older ones and has been used exclusively in the program. Aids of nine different companies have been tried, and the variations that may be obtained with each have given over a thousand different possible combinations that can be used. A properly fitted ear piece is made for each patient in the prosthetic laboratory of the hospital. The technic for making the ear piece is described in detail in another article.[29]

Unless a special ear piece is made, a loss of as much as 20 decibels in efficiency of hearing aid may result. For proper fitting of a hearing aid a thorough knowledge of the characteristics of hearing aids is essential. Complete information regarding the patient should be had—the medical state, the extent and the type of the hearing loss, and the psychosocial status. The audiogram gives essential information from a diagnostic point of view, but it has not proved entirely satisfactory for the proper fitting of an aid. An instrument may not amplify all frequencies equally but may have peaks, and different instruments have different peaks. Even though the characteristic curve of the instrument may mirror the audiogram chart, the aid may not prove satisfactory. The patient who has had a hearing loss for some time may have acquired an abnormal speech-hearing pattern, which cannot be corrected by merely fitting the aid to the audiogram. The hearing aids are grouped into minimum, moderate and maximum gain instruments, and the test aids for the individual cases are selected from the appropriate group. Frequency emphasis suitable for the type of hearing loss is selected in a similar manner. Air conduction hearing aids are more efficient than bone conduction instruments except for patients with bilateral suppurative otitis media and perforation of the tympanic membrane or patients with a moderate loss of hearing due to impairment of the conductive mechanism. The following rules were used in deciding which ear should be selected: If both ears are only moderately involved, so that the patient can still use the phone satisfactorily, the ear not used in telephoning is fitted. If there is a difference between the two ears e. g., an average loss of 40 to 50 decibels in the better ear and 70 decibels in the worse—the better ear is selected. If there is extensive loss, the better hearing ear should be used. The fitting of the hearing aid is

29. Resnick, F. A., and Apter, B. F.: Fabrication of Ear Molds, U. S. Nav. M. Bull., March 1946, supp., p. 226.

normally done one week after admission. By this time the patient has become adjusted to the rehabilitation program and has joined several classes in speech reading and in auditory training in which he has used a group hearing aid.

Preliminary screening tests are done with an average noise level. Various aids are used and tried. A satisfactory instrument has to meet several requirements: "It must produce a gain of 30 decibels or more in speech reception; it must be satisfactory to the patient in terms of tonal quality and of performance in noise; and the amplification of the patient's own voice must be acceptable." Comparative speech reception tests are made in a quiet as well as a noisy environment. The instrument producing the best results is delivered to the patient, and he is given instruction in its use as well as auditory training with it. With completion of this program 94 per cent of the patients fitted with aids have continued to use their aids. To get such results the best equipment and trained personnel are necessary. The complex process of selecting and fitting a hearing aid appropriate to the patient's needs is an essential part of the rehabilitation of the deafened person.

Auditory training, which is the reeducational process of helping the deafened person to use his residual hearing as supplemented by a hearing aid, is an important phase of the rehabilitation program.[30] The two basic principles underlying this work are that the patient must be led to take an objective attitude toward the disability and that he must be trained in the use of means to prevent this disability from becoming a handicap. The training was divided into four fundamental categories: "(1) to condition the rehabilitee to amplified sound, (2) to instruct him in the care and use of his hearing aid in various situations, (3) to present the foundation for an understanding of functional hearing, and (4) to consider post-service problems relative to social and economic adjustments." He is conditioned to the amplified sound coming through the hearing aid with vocal and instrumental music, produced directly from a record player or through a loud speaker microphone, which also permits the introduction of other noises such as are found in fairly normal hearing situations. This is usually done in class sessions. Some part of the class hour is devoted to training in specific hearing. He is then taught the use of his aid in a variety of life situations. Sound effect records are also used to acclimate and accustom the rehabilitee to his aid. Group therapy is stressed as it provides a challenge and fertile ground for normal varied situations and interests. The free interchange of experiences and ideas develops in the rehabilitees intelligent habits of thinking about the significance of their disability. This part of

30. Pauls, M. D.; Haskins, H. L., and Hardy, W. G.: Speech Reading, Auditory Training, and Speech Correction in the Re-Education Program, U. S. Nav. M. Bull., March 1946, supp., p. 232.

the program is closely integrated with speech (lip) reading and speech correction and is carried out as a unified program.

A follow-up study [31] was also made in this program, and replies of 504 hard of hearing veterans disclose that their major problems fall into four categories: (1) taking care of residual hearing, (2) maintaining the maximal performance of the hearing aid, (3) adjusting properly to their jobs and (4) achieving a proper level of mental hygiene in relation to social and economic processes. The proper care of their hearing and the maintenance of the hearing aids should eventually be adequately handled through the facilities of the Veterans Administration. Their adjustment to their work can be maintained by their continuing to feel that they can perform competently and satisfactorily regardless of their hearing disability. The positive conditioning factors set up during the rehabilitation program will continue to operate satisfactorily, provided there is a normal sort of acceptance from the family, the friends and the employer. They are entitled to this understanding and support. These men have been taught to keep their normal habits and attitudes, and they are indoctrinated with the idea that they are normal persons and are advised to solicit the understanding of their friends and family in achieving this goal.

Lederer and Hardy report this complete naval rehabilitation program carried out at the United States Naval Hospital in Philadelphia in more condensed form in a single complete article.[32] In addition, they suggest that these principles should be applied to the treatment and training of the hard of hearing among civilians. There is no apparent reason why this approach and these methods cannot be applied in civilian hearing clinics. Three types of establishments that could serve civilian and future veteran needs of aural rehabilitation are discussed. The first is the university medical clinic that could take care of (1) the treatment and retraining of persons handicapped by defective speech and hearing, (2) the training of professional personnel and the dissemination of public information and (3) research as it applies to disorders of speech, hearing and reeducation. Metropolitan clinics should be available and should devote their efforts entirely to rehabilitative work. They can be developed in conjunction with large hospitals in the cities. These clinics could be self supporting if properly equipped and manned at an approximate cost of 45 dollars per patient. The clinic would furnish all services necessary for diagnosis, treatment, evaluation and fitting of hearing aids, special training in proper utilization of residual hearing

31. Adams, E. L.: Adjustment of Hard-of-Hearing After Leaving the Service, U. S. Nav. M. Bull., March 1946, supp., p. 249.

32. Lederer, F. L., and Hardy, W. A.: Treatment and Training of the Hard of Hearing: A Program of Physical and Psycho-Social Therapy, Arch. Otolaryng. **43**:429 (May) 1946.

and speech reading instruction. Various agencies could utilize these facilities. The Leagues of the Hard of Hearing could also direct their efforts so as to serve the communities on a higher scientific plane. The third type of clinic would be for the rural districts. The rural hearing centers might be mobile units supported by state and educational funds but with a certain percentage of the applicants receiving service on a fee basis. These units might be located also in various county or municipal hospitals, with the services of an itinerant otologist provided as a qualified acoustic consultant. Basic rehabilitative services, however, would be provided by the clinic. Rehabilitative work, through its accomplishments and educational facilities, is also a part of the conservation of hearing program. Through this work, it is hoped that the incidence of handicapping hearing loss will be greatly lessened.

Mary Whitehurst [33] outlines the program of auricular training carried out at Hoff General Hospital. This program is similar to that carried out by the Navy at the United States Naval Hospital in Philadelphia, just reviewed.

The Army opened an ultramodern rehabilitation center for deafened and hard of hearing patients at the Forest Glen Section of Walter Reed General Hospital, Washington, D.C., in September 1946.[34] This center is a continuation of the work done at the Army hard of hearing centers at the Deshon, Hoff and Borden general hospitals, which are now closed. Approximately 250 patients can be taken care of at this center. The unit will have its own laboratory for the making and fitting of individual ear molds. Speech reading will be taught in individual lessons and in class work, and speech correction exercises will be given. The hearing aid most suitable for the patient will be prescribed after several have been tested and tried. There will be a staff of about 50. The course is planned for eight weeks and has as its objective a transformation of every student such that he will be an independent, adjusted person, capable of resuming his place in society with the least economic or social handicap.

The Committee on the Conservation of Hearing [35] report the adoption of a long range program to promote active interest in the conservation of hearing. They propose special studies of specific otologic diseases, also proper legislation and establishment of state programs for the testing of school children, as well as the audiometric testing of adults in the usual routine examinations made in industry, with a view to

33. Whitehurst, M. W.: Auricular Training at Hoff Hospital, Volta Rev. **48**: 277 (May) 1946.

34. Rehabilitation Center for the Hard of Hearing, Government Services, J.A.M.A. **132**:219 (Sept. 28) 1946.

35. Report of the Committee on the Conservation of Hearing, Tr. Am. Acad. Ophth. **50**:143 (Jan.-Feb.) 1946.

prevention, early detection and treatment of hearing deficiencies. They also propose educational and vocational adjustment of those so handicapped. Similarly, they suggest testing of those who served in the Armed Forces, with special reference to treatment and rehabilitation. They endorse and support the work of the Council on Physical Medicine of the American Medical Association. They also propose to promote educational programs for physicians and all others, to acquaint them with the problem of the hard of hearing, to encourage research work along the pertinent lines, to stimulate undergraduate and postgraduate education in otology and to establish otologic rehabilitation clinics in centers of population in cooperation with hospitals and private and public clinics. A special program was arranged and presented at the annual meeting of the Academy, and special courses for the training of assistants for otologists are being sponsored.

Considerable attention has been given to the important problem of the methods of fitting hearing aids. The ideal solution will be the establishment of special clinics similar to those established by the Armed Forces in their rehabilitation programs. In the meantime, they suggest depending on reliable companies and representatives for aid and assistance.

The Committee has endeavored to develop a standardized audiometric chart, but find it advisable to defer this in view of the fact that the methods of testing are still in a formative stage, environmental testing conditions are not uniform, audiometric testing technics are not standard, and there is a possibility that a change will be made in the frequencies used on audiometers, so that even numbers will be used.

Ewing [36] contributes a description of British hearing aid clinics. Three committees were set up: (1) medical and surgical; (2) a committee on educational treatment of deafness; (3) an "electroacoustical committee." Financial support is given through the Medical Research Council. The experimental work is being done at the National Hospital, Manchester University, and at the National Physical and Post-Office Research laboratories. Veterans are not overlooked, but the main objective is to deal with defective hearing in children and civilian adults. The otologic research, under Dr. Hallpike, admits patients at a small fee. The Manchester University duplicates their equipment and serves without fee. There is a small number of hearing aid clinics in London and elsewhere. It is the responsibility of health authorities to care for handicapped children. Courses of instruction with respect to tests of hearing are offered to medical officers, nurses and health workers at different centers in England and Scotland. At the aforementioned university pure tone audiometry and speech tests are used under two

36. Ewing, A. W. G.: Hearing Aid Clinics in Britain, Tr. Am. Otol. Soc., to be published.

sets of acoustic conditions: those of normal quiet conversation and those found in schools or noisy auditoriums. No child is admitted to a school for the deaf who is able with a hearing aid to make progress in an ordinary school. The successful use of aids and lip reading depends on efficiency of training and cooperation of teachers and fellow pupils. Children who come to school "dumb" and those partially deaf should not be educated in the same school, but some of the partially deaf may have to have part time instruction in lip reading and speech correction.

One hundred patients with an average of 62 decibels of hearing loss were tested, and the accuracy with which they followed sentence lists was scored as follows:

(*a*) Unaided hearing without lip reading	21 per cent
(*b*) Unaided hearing with lip reading	64 per cent
(*c*) Individual vacuum tube aids without lip reading	64 per cent
(*d*) Individual vacuum tube aids with lip reading	90 per cent

Children of preschool age received more attention during the war on account of their mothers' doing war work.[37] This led to discovery of heretofore unsuspected deafness. Patients are referred by doctors to the clinic with which Ewing is associated. He writes: "We plan to find to what extent the child can hear spoken voice. Our methods of testing infants and young children have been described in the *Journal of Laryngology and Otology*. Under 3 the tests are made without the child's conscious cooperation. Older ones are trained to cooperate and to respond first to visual signals and later, if they can, to sound signals. The auditory stimuli are those which win most quickly the interest and response of ordinary children at each age level." In the second half of the first year, reflexes give way to learned responses, capacity to locate sound is developed, skill in distinguishing different complexes and meaningful sounds is considerable (click of key in door, clink of feeding bottles), and voice gains the child's attention at this age. From 1 to 2 years of age simple speech and calling the child's name elicit responses; whisper is unsuitable for tests; quiet speech is better than loud. After age 2, speech is most suitable, as is a variety of meaningful sounds. Pitch pipes from 120 to 1900 cycles are useful in testing frequency range response. After 3 years whisper may be used. Audiometric tests are unsuitable for the patient under 5, as the child's interest in pure tones flags. On the basis of the findings advice is given in regard to home treatment that encourages the child to vocalize and to listen and watch the speech of other people. While the baby is close to his mother, she can help him practice listening with the unaided ear. The development of speech is aided by an early beginning of lip reading. After age 3 a hearing aid is prescribed, provided the train-

37. Ewing, I. R.: Clinic for Deaf Underfives, Tr. Am. Otol. Soc., 1946.

ing is carried out by a fully qualified persons. For the child who becomes totally deaf at 10 or 18 months, training is carried out in the home, which is of a type to conserve the natural tone and use of the voice and also to make a beginning of lip reading. The voices of congenitally deaf children are natural in quality and inflection during the first 9 to 12 months, but they tend to deteriorate quickly from 15 months onward unless preventive training is given by the parents. Home training on these lines, if begun at the earliest possible moment, can bring about most gratifying results. (Three cases are described: one in which training began at 4 weeks; one, at 1 year 4 months; one, at 1 year 5 months.) Patient 1 responded only to bell, not to voice; patient 2 responded to a loud voice directed into one ear; patient 3, only to a loud bell. Patient 1 learned to talk freely; patient 2 learned to read lips at 21 months and has a loud, clear voice; patient 3 at 32 months reads the mother's lips and speaks a few words.

The program for the prevention of deafness in children carried out in Washington County, Maryland, is presented.[38] Through the interest of the local health officer and a local otolaryngologist, plans were made in 1942 to operate a clinic offering the best available methods of diagnosis and therapy with all needed facilities and instruments, without arousing any antagonism. The clinic's activities were limited so as not to compete with local medical practice. The first patients accepted were referred by private physicians for consultation and from other agencies after the project had been properly cleared through the family physician. Arrangements were made with the Maryland School for the Deaf for a proper screening of Washington County school children. Two hundred and fifty children with apparent hearing defects, 91 of whom had serious defects, were discovered by this means and seen in the clinic during the first year. Each patient was given a complete examination of his ears, nose and throat, including a nasopharyngoscopic examination. Clinics were held two or three days a month, from 9 a. m. to 4:30 p. m., during which time about 4 new patients were examined in an hour and 10 returning patients rechecked during the same length of time. Histories are carefully taken and recorded, and records are carefully kept by a secretary. Hearing tests were made by a trained technician. No soundproof room has been provided as yet. Young children, usually under 5 years of age, are tested with the 512 tuning fork and the voice, an electric masker being used to exclude the ear not being tested. Patients who can cooperate are given an audiometric test. Screenings carried out at the schools by the health department's technician for third to sixth grade children were checked with spoken and whispered voice, and in some

38. Proctor, D. F., and Willard, W. R.: Washington County (Maryland) Program for the Prevention of Deafness in Children, Arch. Otolaryng. **43**:462 (May) 1946.

cases threshold hearing for 512 and 8192 cycles was determined. Those suspected of having a hearing impairment were carefully reexamined at the clinic and given a complete hearing test. Necessary treatments were carried out, such as irradiation. Those requiring ordinary therapeutic measures, including surgical procedures, are referred to local physicians and surgeons. Up to the time of report (July 1946) 700 new patients had been seen in over 1,500 clinic visits. Only 13 per cent of the patients were over 20 years of age, and 14 per cent were under 5. About 100 patients had chronic or recurrent aural infections, and over 250 showed definite hearing losses, 200 of whom had involvement for the conversational tones. One hundred and eighty ears with hearing impairment have returned to normal, 90 ears have improved, 140 ears have shown no essential change, and 25 ears have shown some increase of impairment. Radiation therapy has been employed extensively for many conditions, including recurrent infection of the upper respiratory tract, recurrent involvement of the ear and chronic suppuration of the ear, with marked improvement of most conditions. It is hoped that a high percentage of all children in Washington County suffering from early impairments of hearing related to conditions of the ear, the nose and the throat will have been seen at the clinic at an early age, when therapy is relatively simple and extremely effective. In a generation or two the percentage of adults suffering from chronic conditions of ear, nose and throat and from impairments of hearing will be greatly reduced if the program proves successful. Cooperation and interest of a health officer and an otolaryngologist are essential to carry out such a plan successfully.

Montague[39] brings out the importance of the constructive information and advice which physicians and otologists should give to parents of hard of hearing children and to deafened adults. There is rarely a deaf or a hard of hearing person for whom something cannot be done educationally. Every child should be given the benefit of a sustained consistent effort to see that he uses every bit of residual hearing. The adult must be properly advised as to whether a hearing aid is suitable and how he should go about getting a suitable one, also as to where and how he can obtain lip-reading instruction and where he may go for vocational aptitude tests and psychologic tests if they are indicated. The physician should be able to offer constructive advice to the patient whom he cannot help medically and should have at hand accurate and definite information as to what may be done for such a patient. He should be acquainted with the facilities offered by various local and national organizations, and should do his part in cooperating with them.

39. Montague, H.: What the Otologist Should Know About the Educational Problems of Deafness, Laryngoscope **56**:305 (June) 1946.

HEARING AIDS

Hearing Aids Accepted by the Council on Physical Medicine of the American Medical Association.—The following instruments had the approval of the Council as of Nov. 1, 1947:

Aurex (Semi-Portable)	J. A. M. A. **109**:585 (Aug. 21) 1937. (tube)
Aurex Model C-B and Model C-A Mfr. Aurex Corporation 1117 North Franklin Street Chicago	J. A. M. A. **120**:535 (Oct. 17) 1942. (tube)
Beltone Mono-Pac	J. A. M. A. **130**:637 (March 9) 1946. (tube)
Beltone Harmony Mono-Pac Mfr. Beltone Hearing Aid Company 1450 West Nineteenth Street Chicago	J. A. M. A. **133**:543 (Feb. 22) 1947. (tube)
Maico Type K	J. A. M. A. **129**:32 (Sept. 1) 1945 (tube)
Maico Atomeer Mfr. Maico Company, Inc. North Third Street Minneapolis	J. A. M. A. **133**:542 (Feb. 22) 1947. (tube)
Mears Aurophone Model 98 (1947) Mfr. Mears Radio Hearing Device Corporation 1 West Thirty-Fourth Street New York	Report not yet published.
Microphone T-4 Audiomatic Mfr. The Microphone Company 4602 Nicollet Avenue Minneapolis	Report not yet published
Otarion, Model A-1	J. A. M. A. **115**:1101 (Sept. 28) 1940. (tube)
Otarion, Model A-2	J. A. M. A. **125**:849 (July 22) 1944. (tube)
Otarion, Model A-3	J. A. M. A. **132**:1071 (Dec. 28) 1946. (tube)
Otarion, Model A-4 J. & S.	J. A. M. A. **132**:925 (Dec. 14) 1946. (tube)
Otarion, Model E-1 Mfr. Otarion Hearing Aids 448 North Wells Street Chicago	Report not yet published.
Paravox Models VV2 and VV3	J. A. M. A. **128**:879 (July 21) 1945. (tube)
Paravox Models VH and VL	J. A. M. A. **132**:79 (Sept. 14) 1946. (tube)
Paravox Model XT	J. A. M. A. **134**:365 (May 24) 1947. (tube)
Paravox Model XTS Mfr. Paraphone Hearing Aid, Inc. 2056 East Fourth Street Cleveland	Report not yet published.
Radioear Masterpiece	J. A. M. A. **117**:2169 (Dec. 20) 1941. (carbon)
Radioear 45-CM	J. A. M. A. **126**:1151 (Dec. 30) 1944. (tube)
Radioear Model 45-M-magnetic air conduction receiver	J. A. M. A. **127**:219 (Jan. 27) 1945. (tube)

Radioear Model 45-M-magnetic bone conduction receiver Mfr. E. A. Myers & Sons 306 Beverly Road Mt. Lebanon, Pittsburgh	J. A. M. A. **127**:27 (Jan. 6) 1945. (tube)
Ravox (Semi-Portable) Mfr. Zenith Radio Corporation 6001 West Dickens Avenue Chicago	J. A. M. A. **113**:18 (Oct. 28) 1939. (tube)
Silver Micronic Hearing Aid Mfr. Micronic Corporation 101 Tremont Street Boston 8	J. A. M. A. **135**:159 (Sept. 20) 1947. (tube)
Solopak Hearing Aids Mfr. Allen-Howe Electronics Corporation 150 Main Street Peabody, Mass.	Report not yet published.
Sonotone Audicles Nos. 530, 531 and 533	J. A. M. A. **123**:837 (Nov. 27) 1943. (tube)
Sonotone Model 600	J. A. M. A. **131**:523 (June 8) 1946. (tube)
Sonotone Model 700 Mfr. Sonotone Corporation Elmsford, N. Y.	Report not yet published.
Telex Model 22	J. A. M. A. **134**:605 (June 14) 1947. (tube)
Telex Model 612	J. A. M. A. **114**:1634 (April 27) 1940. (tube)
Telex Model 900	J. A. M. A. **117**:1978 (Dec. 6) 1941. (tube)
Telex Model 1020	J. A. M. A. **117**:2072 (Dec. 13) 1941. (tube)
Telex Model 1550 Mfr. Telex, Inc. Minneapolis 1	J. A. M. A. **126**:705 (Nov. 11) 1944. (tube)
Trimm Vacuum Tube No. 300 Mfr. Trimm, Inc. 400 West Lake Street Libertyville, Ill.	J. A. M. A. **133**:542 (Feb. 22) 1947. (tube)
Unex Model "A" Mfr. Nichols & Clark Hathorne, Mass.	J. A. M. A. **134**:254 (May 17) 1947. (tube)
Vacolite Model D Mfr. Vacolite Company 3003 North Henderson Dallas, Texas	J. A. M. A. **118**:896 (March 14) 1942. (tube)
Vactuphone Hearing Aid Mfr. Allen-Howe Electronics Corporation 150 Main Street Peabody, Mass.	Report not yet published.
Western Electric Audiphone Orthotechnic Model	J. A. M. A. **112**:1062 (March 18) 1939. (carbon)
Western Electric Telephone Type Audiophone, Model J-1	J. A. M. A. **125**:849 (July 22) 1944. (carbon)
Western Electric Model 63	J. A. M. A. **131**:895 (July 13) 1946. (tube)

Western Electric Model 64 Mfr. Western Electric Company, Inc. 300 Central Avenue Kearny, N. J.	J. A. M. A. **134**:605 (June 14) 1947. (tube)
Zenith Radionic Model A-2-A	J. A. M. A. **127**:159 (Jan. 20) 1945. (tube)
Zenith Radionic Model A-3-A	J. A. M. A. **127**:159 (Jan. 20) 1945. (tube)
Zenith Radionic Model B-3-A	J. A. M. A. **127**:159 (Jan. 20) 1945. (tube)
Zenith Model 75 Mfr. Zenith Radio Corporation 6001 West Dickens Avenue Chicago	Report not yet published.

Audiometers Accepted.—The following were accepted as of Oct. 17, 1946:

Maico Audiometer Model D-5	J. A. M. A. **114**:139 (Jan. 13) 1940.
Maico Audiometer Model D-8 Mfr. Maico Company, Inc. North Third Street Minneapolis	J. A. M. A. **120**:205 (Sept. 19) 1942.
Sonotone Audiometer, Model 20 Mfr. Sonotone Corporation Elmsford, N. Y.	J. A. M. A. **124**:94 (Jan. 8) 1944.
Western Electric Audiometer, Model 4C	J. A. M. A. **118**:1297 (April 11) 1942.
Western Electric Audiometer, Model 6BP Mfr. Western Electric Company, Inc. 300 Central Avenue Kearny, N. J.	J. A. M. A. **114**:1634 (April 27) 1940.

Selection of Hearing Aids.—Davis and associates,[40] in a comprehensive article, discuss the problem of the proper selection of hearing aids, the requirements, the tests, the difficulties and the general status of this subject. The article is a reprint of report "PNR-7," issued by the Psycho-Acoustic Laboratory of Harvard University to the Office of Scientific Research and Development. The major part of the program has been an experimental study of hearing aids. This study resulted in a point of view quite at variance with the current thought and practice of the aural rehabilitation hospitals.

A preliminary selection or "screening" of hearing aids based on engineering specifications, to determine which of the available makes and models should be considered for "fitting," is both practical and desirable.

The differences found between corresponding models of the leading manufacturers are relatively slight. Further improvement of perform-

40. Davis, H.; Hudgins, C. V.; Marquis, R. J.; Nichols, R. H., Jr.; Peterson, G. E.; Ross, D. A., and Stevens, S. S.: The Selection of Hearing Aids, Laryngoscope **56**:85 (March-April) 1946.

ance is possible but it may not be great. The direction of improvement is clearly indicated, and the attainment is an engineering problem.

The appropriate frequency characteristic of a hearing aid is not correctly indicated by current principles of "audiogram fitting" or "selective amplification." A uniform frequency characteristic that can be varied by a tone control between "flat" and a moderate accentuation of high tones will provide the most satisfactory performance for all or nearly all patients with hearing loss.

Minor variations of the ideal frequency characteristic are relatively unimportant, but the maximum acoustic output must be chosen to suit the tolerance of the patient. Tolerance measurements must be made carefully, with due regard to psychologic factors and the desirability of increasing tolerance gradually by experience. For the usual hard of hearing patient, any detailed "fitting" is wasteful of time and effort. The differentials between instruments that are indicated by most current tests are largely illusory.

Routine test procedures should be designed to detect the patient whose requirements are unusually difficult to meet, necessitating special attention. For such patients, smaller differences between instruments may be significant, and more elaborate selective tests are appropriate. The additional tests most likely to prove useful are those based on (1) the maximum (input) operating range, (2) the maximum articulation score on appropriate word lists, and (3) the minimum signal to noise ratio for intelligibility. Such tests are unnecessary, however, for the majority of patients.

Tentative Specifications for Hearing Aids.—Experimental studies relevant to the optimum electroacoustic characteristics of hearing aids have been conducted at the Psycho-Acoustic Laboratory and the Electro-Acoustic Laboratory at Harvard University and at the Central Institute for the Deaf in St. Louis. These experiments will be reported in full at a later date. They lead to the following suggestions as to the design objectives of hearing aids.

1. *Frequency Characteristic: Range.*

The overall acoustic frequency characteristic of a hearing aid should be uniform (i. e., without sharp peaks or valleys) between a lower cutoff frequency not higher than 400 c.p.s. or lower than 200 c.p.s. (and preferably at 300 c.p.s.) and an upper cutoff frequency not lower than 3,000 c.p.s. (and preferably at 4,000 c.p.s.). The response contour should be smooth at the maximum power-output level as well as at ordinary operating levels. The high-frequency cutoff can be as abrupt as engineering convenience requires. Below 200 c.p.s. the frequency response should fall off at a rate of at least 10 db. per octave, and a sharper cutoff is permissible.

a. The desirability of avoiding resonant "peaks" and "valleys" is considered obvious, but no data are available on which to base a minimum requirement of uniformity.

b. There are positive advantages in the cutoffs at 300 c.p.s. and 4,000 c.p.s., in addition to engineering difficulties in providing wider ranges.

1. Frequencies above 4,000 c.p.s. add little to the intelligibility of speech, even for normal listeners. Most hard-of-hearing patients are so deaf to frequencies above 4,000 c.p.s. that these higher frequencies cannot be heard at any comfortable level. Many who do hear them are greatly annoyed by sounds containing them, which detracts from any usefulness they might have.

2. Low tones, whether speech or noise, when amplified to high levels gain disproportionately in loudness, owing to the shape of the equal-loudness contours. The result is an unpleasant "booming" quality. Low-pitched components of ambient noise or of a background of mixed conversation, when amplified to high levels, mask higher-pitched components of speech.

3. An imperfectly fitting or leaky earpiece will cause attenuation for frequencies below 300 c.p.s., but this method of producing low-tone attenuation is undesirable because of the danger of acoustic feedback.

2. Frequency Characteristic: Slope.

Between the cutoff frequencies of about 300 and 4,000 c.p.s. the overall slope of the frequency characteristic should be "flat" or should rise toward the high frequencies with a slope of not more than 1 db. per octave. An adjustable tone-control should provide an alternative slope, rising evenly toward the high frequencies at between 6 and 7 db. per octave. These two extreme adjustments are required. At least one intermediate setting or a continuously variable tone control is recommended.

a. An instrument with a tone control which can be readily switched by the wearer is preferable to separate models with different fixed frequency characteristics, because:

1. If both extremes are available in a single instrument, the problem of "fitting" the individual patient is greatly simplified, and

2. A patient may find it advantageous to vary the tone control according to the amount and character of ambient noise or the presence of clothing worn over the microphone.

b. The possible value of a characteristic rising 9 db. per octave is still uncertain.

3. Limitation of Maximum Acoustic Output.

Maximum acoustic output should be limited so that the ear is protected against powerful transients.

a. Of the available devices the simplest is the "peak clipper." Properly adjusted peak clipping protects the ear from discomfort and pain while allowing a predetermined maximum amplitude of signal to be delivered. The intelligibility of speech is not seriously reduced by as much as 12 db. of peak clipping.

b. "Compression amplification" produces less amplitude distortion than simple peak clipping and if an effective compressor can be built into a wearable hearing aid it may provide the ideal means of limiting the maximum acoustic output.

4. Desirable Limiting Levels.

The instantaneous acoustic output, measured as pressure under a receiver, at which limiting (by peak clipping or compression) occurs should be definitely

established, either by a semipermanent adjustment, or by choice of battery voltage, or by the provision of three or four models with significantly different maximum acoustic outputs. The following permissible ranges are suggested.

Range	Max. instantaneous acoustic output re .0002 dyne/cm²
Beginners'	110 to 117 db.
Low power	118 to 123 db.
Standard	124 to 129 db.
High power	Above 129 db.

The beginners' range is appropriate for individuals who are unaccustomed to loud sounds or are psychologically averse to them. Most of these individuals will, after a period of auditory training, accept (and obtain better results with) a higher limit of acoustic output. The high range will be desired by a small minority of individuals with severe hearing losses and high tolerance thresholds. Their individual earpieces must be fitted with special care to avoid acoustic feedback when maximum gain is employed.

5. Sensitivity, and Freedom from Internal Noise.

The instrument must be sufficiently sensitive and free from electrical or other internally generated noise to allow it to render intelligible to a normal ear speech delivered to it at a level not more than 10 db. above the unaided threshold of intelligibility of that same normal ear. . . .

6. Acoustic Gain.

Patients' requirements in regard to amplification (acoustic gain) vary so widely that it is probably desirable to design at least two or perhaps three different models of hearing aids. For severe hearing losses a maximum gain for speech of 80 db. should be provided. For mild cases an instrument with a maximum gain of 40 db. or even 30 db. will suffice. A single instrument with a properly designed gain control could cover the entire range of desired amplifications, but it might be unnecessarily large, heavy, and expensive for the patient who never requires more than 30 or 40 db. of acoustic gain. The justification for more than one model is economy of size, weight, and expense; and such considerations may properly determine the maximum gain to be provided by medium-gain or low-gain models. No instrument should, however, have less than 30 db. maximum acoustic gain. . . .

7. Gain Control.

The instrument must be provided with an effective gain control, either continuously variable or with numerous intermediate positions between maximum and minimum. This range should be at least 40 db. The gain control must be designed to avoid accidental or too easy shift of setting, as by contact with clothing, and it should operate roughly linearly on a decibel scale.

8. "Squeal."

There must be no electrical feedback ("squeal") when the instrument is used at maximum gain setting. Acoustic feedback should be dependent on the fit of the earpiece and not on leakage from the receiver itself.

General Comments.

It is anticipated that when instruments conforming to the above specifications are produced the problem of individual selection or "fitting" will almost disappear. It will be necessary only to:

1. Provide a well-fitting individually molded earpiece that is comfortable and at the same time provides adequate acoustic seal, and

2. Select a model with adequate acoustic gain and make the appropriate semi-permanent adjustment to provide the proper limitation of maximum power output. Some indoctrination or training may be necessary, however, before the final adjustment to obtain the highest tolerable level of maximum output is made.

It must be clearly recognized by hard-of-hearing patients and their advisers alike, that *even with the most perfect hearing aid, not all cases will achieve entirely satisfactory results.* No instrument can either restore or substitute for degenerated sensory cells and nerve fibers. And proper indoctrination in the use of a hearing aid and subsequent auditory training will continue to be of great importance for the severely hard of hearing.

Practical Procedures for the Fitting of Hearing Aids.—In the full report, the various tests and methods of selecting hearing aids are critically analyzed, and their limitations are pointed out. A simplified "fitting" routine is suggested, based on the following general principles:

1. *Simplify the objective tests.* Design them to insure adequacy in essentials rather than to try to discover a uniqueness of fit that rarely if ever exists.
2. Design the tests and the routine to *discover any special problem or unusual feature* of a case that may require special or unusual procedures.
3. Keep clear in mind the *medical and psychological aspects of the problem,* including the indoctrination and training of the patient.

The full report must be consulted for details of a suggested routine.

As to the problem of the future, the authors state that it is twofold: . . . *the engineering problem of constructing an improved hearing aid according to known design objectives, and the psychological problem of teaching the patient how to make the best use of his remaining faculties with the assistance of his hearing aid.* The problem of the selection of a hearing aid may still call for expert advice of technical details, but it is likely to turn less on acoustic and more on economic factors as the various manufacturers converge on similar design objectives.

Harvard University Psycho-Acoustic and Electro-Acoustic Laboratories and the Central Institute for the Deaf, in St. Louis, have played an important part in the development and study of "instrumental aid to hearing."[41] Under the Office of Scientific Research and Development, they have devised new methods of testing returning veterans for hearing defects. All currently approved commercial hearing aids have been thoroughly tested. A blueprint of the ideal hearing aid has been made, which will greatly aid the general public when the instrument can be made. There was much less difference of performance among various aids than was anticipated. A hearing aid, it was found, cannot be prescribed as eyeglasses would be, on the basis of selective amplification. Better results were obtained with an instrument providing high fidelity amplification over an adequate range of frequencies. The instrument should deliver speech at the maximum necessary loudness with a mini-

41. War Time Research on Hearing Aids: A Release from Harvard and Central Institute, Volta Rev. **48**:225 (April) 1946.

mum of distortion. In cases of severely impaired hearing greater care must be taken in designing the best instrument. Although more amplification is required, the maximum output has to be limited to avoid uncomfortable and painful reactions. This limiting, however, makes loud speech unnatural and less understandable. Hearing aid performance is best if no limiting is introduced until the speech has reached the greatest loudness that the patient is willing to accept. Special equipment was planned and assembled for the military hospitals, both Army and Navy having rehabilitation programs. This equipment was for testing the impairment of hearing and for selecting the best suitable hearing aid for each patient. The new methods of testing are based on the ability to hear and understand speech. These tests, made in a soundproof room, employed carefully chosen lists of words or sentences, which were delivered either through a loud speaker or through ear phones controlled and regulated electrically. Tests were standardized by using carefully controlled live voice or recordings. The Central Institute for the Deaf also carried out tests to provide basic information for the designers of hearing aids. Limits of tolerance were determined for normal and hard of hearing ears. It was shown that the hard of hearing group are neither more nor less sensitive than those with normal hearing. Increasing loudness of sound produces first an uncomfortable feeling, then a tickle deep in the ear and finally a sharp unmistakable pain. After a brief experience of loud sounds, all subjects were able to tolerate speech at a volume that had originally caused discomfort. The Harvard laboratories studied in detail 14 makes of electrical hearing aids. This study served as a guide for the Army and Navy in the procurement of hearing aids and also gained basic information for the designers of hearing aids.

Carhart [42] presents a practical procedure for aiding the patient to select a suitable hearing aid. It can be carried out by the otolaryngologist, who should see that his patient gets an instrument which gives adequate help and is not dangerous. It is applicable to most adults and to some children who have not been handicapped too greatly by their hearing deficiency. There are certain criteria with which a hearing aid should comply to be satisfactory. It should have adequate sensitivity and gain, be tolerable in relatively strong sound environments, be efficient in the presence of background noises and yield adequate sound discrimination, so that small sound differences can be recognized. The instrument should be of a reputable manufacturer whose local facilities are adequate for proper maintenance, and the patient must have no increased difficulty with the aid and should be emotionally satisfied. The procedure proposed for the selection of the hearing aid consists of three screening stages. The first stage eliminates undesirable aids by eliminating those

42. Carhart, R.: A Practical Approach to the Selection of Hearing Aids, Tr. Am. Acad. Ophth. **50**:123 (Jan.-Feb.) 1946.

not accepted by the Council on Physical Medicine of the American Medical Association and those not having adequate or any local representation. This will reduce the number of suitable aids from 40 to 4 to 8. The second stage includes the proper medical and auditory examinations to determine whether a hearing aid is necessary and what actual fittings are essential. A general loss of at least 35 decibels by air conduction for 512 through 2048 cycles per second has occurred in the better ear before a patient requires a hearing aid. The poorer ear is preferred unless the loss is so great that satisfactory results cannot be expected. Air conduction receivers are preferred over bone, unless there is some mechanical or definitely pathologic contraindication to the wearing of an ear mold, such as malformation of the canal or a defect or a suppurative process of the middle ear. An individual ear mold is obtained for the patient, and then the proper hearing aids are recommended. The recommendation is done by utilizing the information which the manufacturers submit. Most of them have fitting systems based on the pure tone audiogram; so by referring to the patient's audiogram, one can choose the proper model, taking advantage of the manufacturer's experience and recommendations. This procedure can be carried out with each make of instrument found applicable to the patient. The performance of each instrument is then checked by actual trial; for this either direct conversation or phonographic material is used, and the performance is recorded in terms of sensitivity for faint speech and loud sounds and ability to discriminate speech sounds. In this way the best combination of each make can be determined. The final screening stage is the testing of the suitable aids in every day situations and subjecting them to a "listening hour" trial. The everyday situations are found at movies, at lectures, at conferences, in restaurants and other similar places in which the aid will have to be used. For the "listening hour" test, a good phonograph with volume control connected to a high fidelity loudspeaker through an appropriate amplifier is necessary. Various samples of music, speech, noises and other sound combinations are presented, about one-half minute being used for each sample. Each hearing aid is checked with this test and the performance score made. When the performance scores of two or more aids are close, supplementary factors must be taken into consideration, such as local service and repair, initial price and cost of maintenance, convenience of manipulation and use, and esthetics. When the final selection is made, the otologist should instruct the patient to return with the instrument which he is going to purchase, for a final check. The patient should also be told that auditory training and reeducation may be necessary to obtain the highest efficiency from the aid, and he should be referred for that training if it is available. If it is not available, the otologist may utilize a specially trained assistant to carry out such reeducation. This program safeguards the adult

patient, permitting sufficient trial and experience to expose any special problems which might arise, gives the patient an opportunity to compare various aids and by elimination retains the one most suitable for him. As stated, an assistant may be trained to carry out part of this program. Such a procedure has real merit where a hearing aid clinic is not available.

Carhart [43] also presents the procedure employed in the selection of hearing aids at Deshon General Hospital. These follow essentially the plan carried out by the Navy, a report of which is abstracted in this review. There are three goals to this program.

1. To secure for each man a hearing aid having optimal efficiency in everyday situations.
2. To give the man an understanding of hearing aids, establish habits of efficient use, and initiate auricular training.
3. To foster in the patient a full psychologic acceptance of hearing aids.

The patient's auditory disability is thoroughly analyzed by means of a medical examination and diagnosis, a determination of his hearing loss and a measurement of capacity for auditory training. A decision is then made as to whether the patient should have a hearing aid and, if so, what type would be best suited to his needs and which ear should be fitted. An individual plastic ear piece is made, and another audiometric study is made to confirm the preliminary analysis. He then goes through various individual and group interviews and the process of selecting a proper aid. After the proper fittings have been determined and picked out, they are tried out with various tests and in a special session known as the "listening hour." The three hearing aid combinations rated highest are then put through the hearing aid evaluation test described previously in this review. The time taken for this procedure is from seven to fifteen days, during which the patient has been properly oriented in the use of hearing aids and a groundwork for further auricular instruction has been laid. The details of this program are described by Carhart in twelve steps and should be read by all interested in this work.

The Committee on the Conservation of Hearing [44] presents a concise report crystallizing its views on the role the otologist should play in the fitting of hearing aids. They realize that the otologist cannot give the patient the service and the advice that the rehabilitation programs and the few civilian clinics can give. However, he can give the patient helpful and correct information with regard to hearing aids. He should

43. Carhart, R.: Selection of Hearing Aids, Arch. Otolaryng. **44**:1 (July) 1946.

44. Conservation of Hearing: The Otologist's Role in the Fitting of Hearing Aids, Committee on the Conservation of Hearing, Tr. Am. Acad. Ophth. **51**:215 (July-Aug.) 1946.

explain to the patient the differences between various types of aids, how much help the patient can expect from one, the nature of the voice heard through the aid, which is similar to that coming over a public address system, and also the fact that sounds other than the ones the patient wants to hear and has not heard, e. g., various street noises, will also come through and will have to be tolerated. The otologist should see that the patient tests the hearing aid under conditions and in surroundings in which the latter expects to use it, and, if possible, that the aid be taken out, on a rental fee, for a complete and careful trial. A properly fitted ear piece should be made, and the otologist should either make the impression himself or see that the patient has a satisfactory one made.

A hearing aid is indicated when the threshold of hearing of the better ear shows a loss of 35 decibels or more across the speech range which is not remedial and which handicaps the patient in his occupation or social life. The otologist should further instruct the patient as to the proper type of aid and the one which will prove most satisfactory. A bone conduction receiver should be used when an ear mold is contraindicated. Before purchasing the instrument, the patient should return for an evaluation of the performance of the aid. The patient should be impressed with the importance of learning lip reading to supplement the aid and of returning at intervals for an otologic checkup and information regarding improvements of hearing instruments. If a reputable hearing aid clinic is available, the patient should be referred to it, and if not, to the local chapter of the American Hearing Society, for further aid and training.

Kemisky [45] states that a hearing aid should never be recommended without a thorough preliminary examination and analysis of the hearing status. Only a small portion of the great number of people with impairment of hearing due to otosclerosis have an impairment which can be aided by the fenestration procedure. After a preliminary examination of the ears, the nose and the throat, careful tuning fork and audiometric tests should be made in a soundproof room. Hearing aids are not indicated when there is less than 25 per cent hearing loss in each ear or when the loss is 75 per cent or more. Lip reading should be employed when the loss is of the latter type. The ear with poorer hearing should be fitted if it offers prospects of an improvement of hearing of at least 35 decibels and if the better ear has some residual hearing. The better ear should be fitted if the hearing of the poorer ear is below the level of possible improvement.

Bone conduction receivers are indicated only for the patient with a discharging ear or the one whose bone conduction is more than double

45. Kemisky, J.: Hearing Aids: The Otologist's Problem, Virginia M. Monthly **72**:464 (Nov.) 1945.

his air conduction—e. g., a patient whose air conduction threshold is 40 decibels lower than his bone conduction threshold. More attention should be paid to bone conduction. A comparison of the air hearing and the bone hearing graph should determine what type of hearing aid to recommend. The instrument selected should fit the area of residual hearing which requires amplification as disclosed by the audiogram and a controlled speech test. Hearing aid clinics should be available. The modern hearing aids have various adjustments for frequency, tone and sound volume control, to provide selective amplification. To match these adjustments to the individual case requires a high degree of otologic knowledge and experience, as well as a thorough knowledge of the instruments themselves, and skill in handling them.

Siirala [46] examined 685 persons wearing hearing aids. It is possible to better the hearing if the patient can distinguish loud speech. The hearing aid is of greatest benefit to those who can hear normal speech up to a distance of 2 meters. If the hearing is "above 4 meters," the aid is not indispensable. The hearing aid is less efficient in cases of inner ear deafness than in those primarily of conduction deafness. Of patients with chiefly conduction deafness who heard normal speech at less than 0.5 meter, 11 per cent had no benefit; 5 per cent had hearing at less than 4 meters; 5 per cent, at 4 meters or better; 15.3 per cent at 6 meters. Of those with conduction deafness, 2 per cent heard no better with the hearing aid; 47.3 per cent still had hearing at less than 4 meters; 5 per cent, at 4 meters or better (2.3 per cent heard at 6 meters or better). Those suffering from presbyacusis average less benefit than younger people, regardless of cause. The frequency of inner ear deafness increases with age. Permanent deafness caused by disease of the middle ear was rare under 21 years, plentiful between 21 and 60 and then again less.

Myklebust [47] reports observations gained from a study of 40 children wearing portable hearing aids over a period of from one to three years. There is increasing ability to discriminate and comprehend speech sounds during the first year of wearing the hearing aid. This suggests that an average of at least one year of constant acoustic stimulation is required to establish a sound pattern. Children fitted with an aid before 10 years of age made more rapid progress than those fitted after 10 years of age. The aid should be fitted at the earliest practical age. Children who had a loss of more than 90 decibels in the speech range did not learn to discriminate or to comprehend speech sounds. They reported, however, that it helped them to read lips. Children having a 90 to 94 decibel loss for the speech range were successful in acquiring an auditory

46. Siirala, U.: Regarding Improvement of Hearing with Hearing Aids, Acta oto-laryng. **33**:127 (April 30) 1945.

47. Myklebust, H. R.: The Use of Individual Hearing Aids in a Residential School for the Deaf with Implications for Acoustic Training, Am. Ann. of Deaf, **91**:255 (Sept.) 1946.

pattern, provided they had normal hearing prior to sustaining their auditory impairment.

The hearing aid is fitted to the patient rather than to the ear. Each child is counseled frequently, to stimulate and maintain a minimum of motivation. In a group of 30 who had an average loss of 75 decibels for frequencies 512 through 2048, normal aural comprehension was developed without exception. In a group of 9 children with an average loss of 76 to 89 decibels, slightly less rapid progress and more varied success were noted. In a third group in which only 1 child was wearing an aid and which had an average loss ranging from 90 to 94 decibels, the response to acoustic training depended on factors other than hearing, such as adjustment and intelligence. In a fourth group in which none wore an aid, with an average loss between 95 and 100 decibels, acoustic training seemed not to be indicated unless the child had retained his sound pattern after being deafened to this degree.

Patten [48] outlines the work she is doing in connection with the Winthrop Foundation of the Massachusetts Eye and Ear Infirmary in Boston. She works with young children, some as young as 2 years of age. All have hearing aids. The program is well organized, and a complete study of each child is made before special instruction is given. This includes an otologic study, a study of hearing, a psychometric evaluation, a general physical examination and social studies. After these studies are made, they are presented to a clinic of consultants, who decide on the therapy to be employed—a surgical procedure, such as removal of the tonsils and adenoids, lip reading, fitting of a hearing aid or training in a school for the deaf. Those requiring a hearing aid are turned over to the author. For each individual patient there is a definite program, which includes development or correction of speech, development of vocabulary, development of hearing by means of the hearing aid, lip reading and beginning reading. The fitting of the hearing aid should be done by an expert and at the earliest practical age. The sense of hearing is developed by the use of cymbals, bells, whistles and horns, by playing phonographic records of animal noises, by change of accent and change of pitch and eventually by use of nouns, commands, descriptions of pictures and objects and telling of stories. The time necessary for a child to learn to use his hearing aid varies, and progress may be slow in some cases.

Fowler [49] reports his successive findings in 100 children who were examined at least once a year for three years. These children were

48. Patten, H. T.: Fitting the Young Hard of Hearing Child for School Through the Auditory Approach, Volta Rev. **48**:102 (Feb.) 1946.

49. Fowler, E. P.: The Value of Individual Hearing Aids for Hard of Hearing Children in Public Schools: Report to the Sub-Committee of the Committee on Problems of Deafness of the National Research Council; the Otological Examination and Follow-Up, Laryngoscope **56**:26 (Jan.) 1946.

paired; one of each pair wore a hearing aid during this period. The gain or loss reported is for speech sounds instead of frequencies, and Fowler's method of weighing is used. Fifteen of 31 children having purely obstructive deafness, not over 30 per cent of whom had dry or suppurative otitis media and mastoiditis, showed improvement at subsequent tests. The remaining 16 children having purely obstructive deafness had a loss of more than 30 per cent at the first test; 4 subsequently showed a greater loss (only 1 over 5 per cent), and the hearing of all but 3 improved to the 30 per cent loss line or above. None of these had any definite medical care, but instructions were issued to the parents as to proper preventive measures. None of the 8 children whose deafness was of the pure nerve type showed any further progress of loss, and 1 revealed an improvement of 33 per cent. Of 57 children who had nerve deafness with some obstructive deafness, the great majority showed considerable gains; however, only 11 per cent regained enough hearing to function well for soft voice more than 5 feet (1.5 meters) away, equivalent to less than 35 per cent loss. Four of the 5 children who had obstructive deafness with some nerve deafness showed variable gains, and 1 showed a slight loss.

Over 75 per cent of the children examined and followed improved to some extent, and at least one third showed marked restoration of hearing. About 40 per cent improved to the 30 per cent loss level. This can be attributed only to a natural course, as no special treatment or cure was utilized. The hearing aid had no effect on the basic hearing capacity. The hearing variations observed among the patients were so great that any genuine differences between the groups were obscured. The small number of patients utilized in this test likewise made it impossible to recognize definite differences between the two groups. Those with hearing aids showed a trend toward improvement in social and school adjustment and achievement.

The electrostethoscope is a portable device used to amplify fetal and adult heart sounds for recording on records, film or wire.[50] The microphone is attached to the hearing aid by a screw plug; the ear piece, to the top of an ordinary binaural stethoscope. Heart sounds are transmitted to the ears when the microphone is placed over the precordium. Tone and volume are controlled by means of dials on the amplifying unit of the hearing aid. Murmurs are amplified; fetal heart sounds can be heard.

Sonday [51] reports in detail a simple and economical method of making a satisfactory ear mold impression which was employed success-

50. Kirschbaum, H. M.: Stethoscope for Doctors with Hearing Defects, Am. J. Surg. **70**:134 (Oct.) 1945.

51. Sonday, F. L.: A Simple Method of Taking Earmold Impressions, Tr. Am. Acad. Ophth. **50**:179 (May-June) 1946.

fully at Deshon General Hospital in the Aural Rehabilitation Program. This procedure can be used by any otologist who wishes to assume this service in the interest of the hard of hearing patient. It can be made in his own office, and he can check and be sure that a properly fitting ear mold is provided. The acrylic impression material has been found most efficient. The technic of making it and taking the impression is described in detail. The finished ear mold should be checked and inspected for various things. The surfaces of the mold should have a high polish and no abrasions; the end of the canal portion should be tapered, smoothed and rounded; the sound channel should be clear of all foreign material, smoothed and rounded and as large as is commensurate with the size of the canal portion of the ear piece. The surface to which the hearing aid receiver is attached should be perfectly flat or convex. The metal insert ring should be checked for proper seal and the spring in the ring tested to determine whether it is holding the receiver tightly. The ear piece with the receiver is then checked to see that it is easily inserted into the canal without producing irritation though fitting snugly. The posterior portion of the ear mold should then be inspected to see that it fits the rim of the concha adequately. The hearing aid receiver should have sufficient clearance between it and the auricle, not more than 1/64 inch (about 0.4 mm.). Any otologist making his own ear mold impressions should carefully read this paper.

Hipskind [52] investigated a large group of combatant personnel under adequate conditions, using a soundproof room, a standardized audiometer, proper masking when indicated, and careful rechecking. He found that all who had been exposed to battle noises demonstrated a tonal dip maximal at 4096 cycles. In a series of cases in which there was complaint of some aural difficulty a greater tonal dip was noted at 4096 cycles, which included also the threshold at 8192 cycles. Another group of officers was tested, who had been exposed to combat noise but gave no past history of ear trouble and had no complaints of ear, nose or throat. These showed a maximal dip at 4096 and a second dip at 8192 cycles. All of these gave a 15/15 response to the Army whisper test. A miscellaneous group was tested, who had not been exposed to battle noises but had other aural complaints; they had a flat auditory threshold without any definite dips. A normal group with no aural complaints and with no history of having been exposed to combat or rifle noise revealed no involvement of hearing at all. The tonal dip could be recognized in cases of injury of the ears incurred in combat before the speech frequency range was affected. Ears in which impair-

52. Hipskind, M. M.: War Injuries to the Auditory Apparatus: Clinical and Audiometric Observations, Laryngoscope **55**:678 (Dec.) 1945.

ment of hearing was present prior to military service were as vulnerable as normal ears when exposed to combat noise. There was no definite correlation between the degree of objective injury of the ear drum and the degree of impairment of hearing. Few of the men complained of any vestibular symptoms or of diplacusis. Tinnitus was a more common complaint. When not associated with deafness, the maximal elevation of threshold was limited to 11,584 cycles. Hipskind describes a "real life test" used for the detection of malingerers. Some mark of identification was singled out or established on the patient; e. g., cotton with some dye was placed in the ear. Red Cross personnel were told to observe the patient carefully without his knowledge. Frequently the malingerer, in order to make an impression, forgets his simulated affliction and exposes himself. Temporary deafness of the left ear caused by the muzzle blast of the soldier's own rifle seemed to predispose the ear to being injured by combat explosions occurring in the area of the soldier's left side. There was no evidence to indicate a possible cumulative factor in acoustic trauma.

One hundred male gunnery instructors were tested before and after being exposed to shotgun and 50 caliber machine gun fire on the ranges.[53] The average age of the men was 25 and the average length of exposure ten months. Each instructor had normal hearing prior to his assignment. This gunfire produced definite loss of hearing, which began in the high tones, 2048 to 11,584 cycles per second, and affected the lower tones also in the cases of more severe damage. The average loss of hearing of both ears was 20 decibels. There was great variation in the degree of involvement and in the length of exposure necessary to produce changes due to individual susceptibility. After an instructor had undergone ten to twelve months' exposure on the range, further impairment occurred slowly if at all. No significant improvement was observed six months after exposure, and the loss is believed to be permanent. Tinnitus of a varying degree was the most annoying symptom noted in 50 per cent of the cases. The change in hearing occurs insidiously and is usually not noticed until it is far advanced. Prearranged routine surveys are necessary to detect this change early. Cotton plugs placed in the external auditory canals have not been effective in protecting the ear. Other protective devices are now being investigated.

Patt [54] reports similar findings from his investigation of 130 artillerymen and 23 rifle coaches. Thirty-eight hospital corpsmen who had no specific history of having been exposed to gunfire were used for comparison. The loss in auditory acuity was significantly greater in the

53. Stewart, J. V., and Barrow, D. W.: Concussion Deafness, Arch Otolaryng. **44**:274 (Sept.) 1946.

54. Patt, H. M.: Auditory Acuity of Artillerymen and of Rifle Coaches, Arch. Otolaryng. **44**:298 (Sept.) 1946.

rifle coaches and the artillerymen than in the hospital corpsmen. The greatest percentage of the hearing losses occurred at the higher frequencies. Most of the men had used cotton plugs during exposure, but that did not prevent the change.

Hall [55] presents a report of the aural, nasal, pharyngeal and oral diseases and defects observed in 344,134 applicants for pilot, navigator and bombardier training who were examined at Army Air Force classification centers and Army Air Force basic training centers. All these men had undergone previous physical examinations at other medical facilities. Of this number, a total of 581 were found to have defective hearing, or 1.69 per thousand examinees; 147 had deafness of the conduction type, 114 of the perception type, and 314 of the mixed type. The group showing aural diseases and defects was the second largest group, the largest being the group with nasal diseases and defects. There were 567 chronic infections of the middle ear in addition to the hearing defects. Only 2 cases of definite otosclerosis were reported. Audiometric examinations were made, as well as other special tests, only when they seemed to be indicated by the medical examiner. No mention is made as to how many of the men with impaired hearing actually had more than the ordinary whispered voice test.

Hendricks [56] observed 52 machine gun instructors of an Air Force gunnery school over a period averaging one hundred and twenty-three days. The number of audiograms made per man averaged 3.8. Forty-five men, or 86.4 per cent of the group, had an increase of hearing impairment during this period, and on the average the loss was greatest for the frequency 8192 cycles per second, 13 decibels in the left and 12 decibels in the right ear. The impairment generally progressed with the length of exposure. Some resisted cochlear damage for months, whereas others suffered severe losses relatively early. No definite recovery of the hearing lost was noted in cases of severe impairment in which tests were made before and after a fifteen day furlough. In 4 men examined after they had been absent from the firing lines for periods of thirty to one hundred and twenty days the recovery was disappointing. Generally, more hearing was recovered for the lower frequencies than for the higher ones.

Henry [57] reports his findings and impressions gathered from 293 men sustaining blast injuries of the ears. Hearing was tested with voice and tuning forks, as an audiometer was not available. Six had residual hearing at 5 feet (1.5 meters) or less for conversational voice.

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55. Hall, D. S.: Diseases and Defects in Air Crew Trainees, Arch. Otolaryng. **44**:319 (Sept.) 1946.

56. Hendricks, J. E.: War Deafness in Gunnery Instructors, Ann. Otol., Rhin. & Laryng. **55**:68 (March) 1946.

57. Henry, G. A.: Blast Injuries of the Ear, Laryngoscope **55**:663 (Nov.) 1945.

in both ears; 44, at 5 feet or less in one ear; 14, at 10 feet (3 meters) or less in both ears; 64, at 10 feet in one ear, and 193, at 20 feet (6 meters) or more in both ears. The appearance of the ear drum was no indication of the residual hearing. More than half the men with hearing at 5 feet or less for conversational voice in one ear never suffered a perforation of the drum membrane. Nearly all the men had a combined conductive and perceptive impairment at the onset. The greatest improvement occurred in the first ten days. In the majority of the men the perceptive hearing continued to show improvement; in a few it showed gradual deterioration. Tuning fork tests early showed a loss throughout the range of 128 to 12,000 cycles per second to air conduction, with greater loss in the upper tones from 2,000 to 12,000 cycles. If the damage was severe, the high tone loss was more evident. During improvement the greatest recovery was in the range from 128 to 2000 cycles, with a lesser degree for the higher tones.

Lederer [58] reports an analysis of 2,500 cases of bilateral deafness encountered in the Navy and Marine Corps at the United States Naval Hospital. The patients were admitted for rehabilitation. In 60.6 per cent of the cases the damage of the ears was incurred in service. In 39.4 per cent the impairment existed prior to service, and in 93 per cent of this group it was aggravated in the service. In those cases in which the impairment existed prior to service it was of three types: the chronic progressive type (in 19.88 per cent of the total number), the nerve type (in 15.12 per cent) and that due to chronic otitis media (in 4.4 per cent). Deafness incurred in the service was for the most part due to heavy gunfire, and the cases of this origin were 26.56 per cent of the total number. Nerve injury was the cause in 15.16 per cent; chronic progressive types of impairment, in 10.32 per cent; chronic suppurative conditions, in 3.6 per cent; machine noises, in 3.6 per cent; trauma of the skull, in 1.08 per cent, and epidemic meningitis, in 1.12 per cent.

Lederer with Hardy report the foregoing facts also in a portion of another article included in this review.[32] In a random sampling of 200 patients having nerve involvement, 56 per cent were found to have been exposed to noise and blast. Seventy-five per cent suffered from severe tinnitus. This points to a relationship between nerve involvement in general and symptoms of deafness produced by heavy gunfire, even to a possible central origin of deafness of this type. Four and four-tenths per cent of the total number of patients had been inducted with chronic suppurative otitis media. Experience gained with these patients revealed the necessity for special recommendations in regard to inductees of this type: No one should be placed on active duty whose

58. Lederer, F. L.: Hearing Loss in the Navy and Marine Corps: Incidence, Etiology, and Statistical Analysis, U. S. Nav. M. Bull., March 1946, supp., p. 194.

ears have been previously affected by some inflammatory disease or who reveals a diminution of hearing, especially for the whispered voice, when tested. If such exclusions had been made, 40 per cent of these men with lateral deafness would have been eliminated.

Goldner [59] classifies cases of occupational deafness as: those due to either acute or chronic exposure to noise; those due to the effects of chemical agents, such as phosphorus, carbon disulfide and paraphenylene dyes, as well as those due to the effects of quinine, lead and tobacco; those due to changes in pressure, and those resulting from trauma, namely, trauma of the skull of any variety. He mentions several groups of occupations in which workers are prone to have deafness after varying periods of employment. These are the metal industries, pneumatic tool employments, spinning and weaving, transportation, aviation and switchboard operation. The diagnosis of chronic occupational deafness is based on a history of exposure to a noise sufficient to cause injury. The drum membrane is normal, and there is an elevated air conduction threshold for the high tones associated with diminished bone conduction. The vestibular responses and the function of the eustachian tubes are normal. Proper selection and examination of prospective workers are recommended. Those with perceptive impairment and purulent otitis media are poor risks, whereas some with chronic catarrhal deafness, on the basis of their fatigue reactions, may be less susceptible and therefore good risks. The mechanical ear protections are not sufficient or practical.

Ruede and Furrer [60] explain the modification of pitch induced in the deafened by a loud tone. When the human ear is exposed to a loud pure tone, the threshold of hearing is raised at frequencies above this tone; modifications of the pitch are explained by a two place mechanism of the inner ear, whereby pitch and loudness are perceived at two different and locally separated places of the basilar membrane.

The Australian forces also made contribution to traumatic deafness.[61]

Gun blast without rupture of the membrana tympani affects mainly the hearing for high frequencies, but the impairment may extend as low as 256 cycles per second. Rupture occurred in position 1 of the short 3 inch (7.5 cm.) mortar when the blast pressure was 6 to 8 pounds per square inch; at a pressure of ¼ pound per square inch from repeated rifle fire, severe loss of hearing will be caused. The observed losses lasted a few hours to several days. Inner ear deafness is more notice-

59. Goldner, A.: Occupational Deafness, with Special Reference to Chronic Occupational Deafness, Arch. Otolaryng. **42**:407 (Nov.-Dec.) 1945.

60. Ruede, L., and Furrer, W.: Acoustic Trauma and Function of the Internal Ear, Acta oto-laryng. **33**:460 (Dec. 31) 1945.

61. Murray, N. E., and Reid, G.: Temporary Deafness Due to Gunfire, J. Laryng. & Otol. **61**:92 (Feb.) 1946.

able at threshold than at higher levels (Fowler's recruitment phenomenon). Cotton wool plugs are inadequate. "Protector Eardrum, Aust. Mk. 1," designed by the Acoustic Research Laboratory gave (British) reasonably complete protection.

Sixty-four unprotected ears of 35 men were examined; 21 different types of gunfire were represented; 8 frequencies from 128 to 9747 inclusive were used, and measurements of blast pressure were made. The audiograms include the nature of the gunfire in each case. Some peak losses were as high as 85 decibels; small arms caused 50 to 70 decibels of loss. A few ears with previous permanent deafness were made worse. Peak losses were usually between 4096 and 8192 cycles, sometimes between 2048 and 4096 and rarely between 1028 and 2048. The deafness was of the perceptive type, and the recruitment phenomenon was common. In some cases rupture of the drum was suffered, and these are included in the résumé.

Curves of recovery are shown; variation is noted in the sensitivity of different subjects; blast pressures of different guns are tabulated; the relation of blast pressure to the aural defect is discussed; hearing loss vs. the peak blast pressure and the significance of deafness following gunfire are considered.

Abstracts from Current Literature

Ear

SURGICAL SUBSTITUTIONS FOR LOSSES OF THE EXTERNAL EAR. J. B. BROWN, B. CANNON, C. LISCHER, W. B. DAVIS and A. MOORE, Surg., Gynec. & Obst. **84**:192 (Feb.) 1947.

A simplified local flap method of reconstructing auricular defects is described and well illustrated in this presentation. Where good adjacent skin is available, the stump of the ear may be freshened and carefully implanted under a flap of the scalp behind and above the ear. In two to three weeks a piece of costal cartilage, properly shaped, is inserted under the flap. Three to four weeks after this, the flap and cartilage are carefully dissected free, leaving soft tissue attached to the under cartilaginous surface and to the skull. The resulting double raw surface is then covered with a split thickness graft. By the use of this technic, total reconstructions have been done in as little as three operations.

Stored costal cartilage, adequately preserved, is favored by the authors. It is carved in the operating room with the simplest of equipment.

When the skin surrounding the ear is limited or too scarred, preliminary free grafting to the area may be necessary. If all local tissue has been previously avulsed, local flaps rather than free grafts may be required to even start the reconstructive process. Markedly deformed cartilage should sometimes be removed in order to start with a smooth surface, even though the overlying skin is good. The use of free grafts from the opposite ear may be considered for small losses of the ear and for restoration of the helix in total reconstruction.

FRIEDBERG, Chicago.

VARIATIONS OF THE PNEUMATIC CELL SYSTEM OF THE TEMPORAL BONE: ACUTE OTITIS MEDIA AND COMPLICATIONS WITH VARYING TYPES OF PNEUMATIZATION. A. J. SEPPÄLÄ, Acta oto-laryng., 1946, supp. 64.

The results obtained by several investigators regarding the relative frequency of the varying types of pneumatization of the temporal bone are not consistent. Furthermore, previous clinical statistical studies dealing with the frequency with which acute infection of the middle ear and its complications are associated with the various types of pneumatization are not supported by comparative normal material illustrating the general frequency of different types of pneumatization of the temporal bone.

Seppälä's investigation has been approached from the standpoint of three general questions:

1. How frequent are different types of pneumatization of the temporal bone?

2. How frequently does acute otitis media occur with the various types of pneumatization?

3. What is the incidence of complications of acute otitis media in the presence of the various types of pneumatization?

Seppälä studied the pneumatic condition of 3,048 temporal bones, which included roentgenograms of the ears of 1,524 recruits aged 20 to 21 years, taken in the

Schüller position. The distance of the sigmoid sinus from the posterior bony canal wall was measured. The frequency with which otitis media occurs in the presence of the various types of pneumatization was studied, with earlier purulent inflammation of the middle ear, as well as acute otitis media occurring in the course of the one year period of military service, being taken into consideration.

The investigation of the frequency with which the complications of acute otitis media occur in the presence of the different types of pneumatization was based on clinical material comprising 711 surgically treated patients among the aforementioned young servicemen.

With respect to the various types of pneumatization, the following classification was reached:

Group 1. Very extensive pneumatization, 3.1 per cent

Group 2. Normal pneumatization, 39.8 per cent

(*a*) Pneumatization regular, 21.8 per cent

(*b*) Pneumatization irregular, 18.0 per cent

Group 3. Pneumatization slightly arrested, 32.2 per cent

Group 4. Pneumatization strongly arrested, 14.9 per cent

Group 5. No cellular development, 10 per cent

In general, the more extensive the general pneumatization, the larger were the zygomatic cells, but zygomatic cells were found present in about 1 per cent of the patients with arrested pneumatic development. Asymmetric pneumatization in which the right and left sides differed as to the extent of belonging to different groups of pneumatization was present in about 20 per cent.

As measured on the roentgenogram, the distance of the sigmoid sinus from the posterior canal wall varied from 3 to 18 mm. The greater the arrest of pneumatization, the shorter was this distance. A markedly anteposed sinus was found only in connection with strongly or completely arrested cellular development. The right and left sigmoid sinuses were situated at different distances from the auditory canals in about 54 per cent of the cases, the right being about four times as often nearer the posterior canal wall than the left.

Among 3,048 cases in which roentgenograms were made, in 11.1 per cent they showed evidence of previous suppurative otitis. Chronic otitis media was shown in 1.4 per cent. In childhood otitis was most frequent in those with strongly or completely arrested cell development. Likewise, in later life otitis was more common in conjunction with arrested than with extensive pneumatization. In the presence of asymmetric cell systems otitis appeared more often on the less pneumatized side. Chronic otitis appeared only in ears with little or no cellular development.

The complications of acute otitis media developed more often in temporal bones with extensive cell systems than in those that were poorly pneumatized. The lowest incidence of complications was observed in the compact temporal bones.

In 88 per cent hemolytic streptococci were causative of the otitis, and in 8 per cent pneumococci type III were found to be the cause.

In comparing the different types of pneumatization with respect to the incidence of mastoiditis, including external perforations and uncomplicated epidural suppuration, 603 cases, this incidence was found to be highest in cases of very extensive and normally extensive but irregular pneumatization and lowest in the cases in which the bones were wholly compact. External perforation was found more often and seen earlier in temporal bones with extensive pneumatic systems, while internal perforation was seen more often in bones with strongly arrested pneumatization. The epidural perforations developing in extensive cell systems

did not lead to complications as often as when they developed in scantily pneumatized temporal bones.

Apicitis (8 cases) was observed generally in cases of extensive cell development. It may occur in the compact temporal bone, but then the infection extends to the pyramid, in the form of osteomyelitis. Labyrinthitis (21 cases) was more common in extensive cell systems.

The incidence of general otogenic sepsis without thrombus formation (24 cases), as well as that of sinus thrombosis (35 cases), was much higher in cases of strongly or completely arrested pneumatization.

As a complication of acute otitis media, primary tympanogenic leptomeningitis (14 cases) occurred considerably more often in bones with strongly or completely arrested cellular development. The usual point of invasion was through the thin tegmen. An unusually thin tegmen and a deep middle cranial fossa offer particularly favorable conditions for intracranial extension of suppuration.

Seppälä's general conclusions are that the serious complications of suppuration of the middle ear, such as petrositis, labyrinthitis, general sepsis and meningitis, are more apt to occur in the temporal bones with either very extensive or strongly arrested pneumatization.

GROVE, Milwaukee.

OSTEOPSATHYROSIS AND OTOSCLEROSIS. E. HENSCHKE, Acta oto-laryng. orient. **1**:67, 1945.

Henschke adds to medical literature a report of another case of the triad of bone fragility, blue scleras and otosclerosis.

There was a strong familial tendency. The patient's father showed the triad; a younger sister has bone fragility and blue scleras, and the patient's daughter, aged 5½ years, has blue scleras. The paternal grandfather had suffered from deafness, but it is not known of what type.

A short review of the problem is included.

JENNES, Waterbury, Conn.

Pharynx

THE ROLE OF MECHANICAL AND ANATOMICAL FACTORS IN THE PROBLEM OF TONSILLAR FOCI. G. REVESZ, J. Laryng. & Otol. **61**:299 (June) 1946.

The controversy as to whether the faucial tonsil is related to focal infection is reviewed. Of the many factors said to play a part in tonsillar focal infection, the author particularly strives to emphasize the lodging of the tonsils between the palatal arcs and the role of the mechanical factors acting on the tonsils.

It was noted that in cases in which an assumption of focal infection was correct as seen from the improvement following tonsillectomy the tonsils were lodged deeply between the pillars. The motions of deglutination were thought, therefore, to have an important role in the production of focal symptoms referable to embedded tonsils. Whereas, when the tonsils are normally situated the constructive action of the pillars and the tongue during swallowing express the tonsillar content toward the oral cavity, deeply seated tonsils are compressed laterally in swallowing with their contents being arrested along lines of least resistance, i. e., toward the capsule. An additional factor in the latter case is a slight torsion about an imaginary frontal axis. This has been demonstrated roentgenographically to the author's satisfaction. Also, the observations made when an opaque medium was injected into the tonsillar crypts and the nasal endoscope used to watch the tonsillar behavior during deglutition seem to bear out these postulates.

Revesz details an experiment to express numerically the pressure exerted by the palatoglossal and palatopharyngeal muscles. This has been calculated to amount to about 0.6 Kg. per square centimeter, representing 0.45 Kg. per square centimeter of pressure tension on the central part of the tonsillar cavity system, i. e., on the imaginary plane lying in the axis of the tonsil.

LeJeune and Steele, New Orleans.

The Treatment of Chronic Faucial Diphtheria by Tonsillectomy. F. Boyes Korkis, Practitioner **156**:450 (June) 1946.

Twenty-seven carriers of diphtheria bacilli were treated by tonsillectomy, with 81.5 per cent being found free from infection by the fourth day after operation. Here in the United States physicians have long known about the efficacy of tonsillectomy in these cases, but this study of a group of British soldiers in Italy helps to emphasize the matter and also brings out several important points. Local or general anesthesia made no difference in the toxicity due to the Klebs-Löffler bacillus. Likewise, penicillin, whether administrated locally or parenterally, before or after operation, failed to influence the period of recovery. In view of the nature of the lesion and its site, prolonged local medication is unlikely to lessen the period of infectivity.

Lieberman Philadelphia.

Some Causes of Hoarseness in Children. Francis W. White, Ann. Otol. Rhin. & Laryng. **55**:537 (Sept.) 1946.

White states that 8 to 10 per cent of the children of the elementary schools and about 8 per cent of those of the high schools suffer from speech defects. Of these defects, hoarse voice is the most common. In general more boys than girls are affected, and among stutterers the proportion may be 8 to 1. One survey of 50 stutterers showed that all but 5 were of superior intelligence. Only about 50 per cent of the patients are examined by laryngologists. In examining these children at the clinic of the Manhattan Eye, Ear, Nose and Throat Hospital, a screening method similar to that used by the Armed Forces was used in an effort to find some underlying causes of the disorder and to eliminate such pupils from group instruction while they are handicapped by remedial conditions. At times there had to be collaboration between the laryngologist, the neurologist, the ophthalmologist and the dentist to complete the diagnostic picture. The ages ranged from 7 to 18 years, with an average of 14 years. This is the age of greatest sensitivity, and psychic shocks and unfavorable impressions are carried over into adult life, acting as a cause of introspection. Also, infectious diseases are prevalent and may be the cause, for example, paralysis following diphtheria, which may have been so mild it is not even considered. Chorea takes its toll. Cleft palate and harelip were not referred to the clinic. No case of abnormally small larynx was seen, and not a single case of papilloma appeared. One case of tongue-tie was seen. Agenesis of the left vagus was found in 1 child. A brother and sister both showed congenital stenosis of the larynx. A lingual thyroid mechanically interfered with another's production of voice, and there were many in whom goiter caused mechanical interference.

Environment is important. A noisy neighborhood, which is also likely to be dusty, causes a child to yell and scream, and this affects the larynx. Home environment is important and if a child is in unhappy home surroundings and is of a sensitive nature, he is at a great disadvantage in trying to become adjusted.

The inflammatory reactions in the average case had the appearance of the so-called "rheumatic larynx," but pain was not a symptom. In all cases the true

vocal cords, but most characteristically the arytenoids, were involved. They were red and moved very sluggishly, owing to the inflammation and the trauma incident to the excessive effort to speak louder. Interarytenoid thickening was seen in only a few cases. "Head cold" was the most common complaint. Catarrhal and suppurative sinusitis were frequent. Often children with mild laryngitis stated they could get along fairly well until suddenly called on to recite or to answer questions. Owing to emotion plus the physical handicap of the laryngitis, they could not phonate. In all cases vocal rest was insisted on, including limitation or elimination of classroom recitations and gymnasium work, and family cooperation was enlisted.

Of the obstructive causes, tonsils and adenoids, with the presence of a deviated septum, predominated. A history of one or more removals of tonsils and adenoids without benefit was so common that when it was given, the laryngologist, instead of examining the throat, first made a nasal examination to see whether the real cause was not a nasal obstruction.

Hardness of hearing in either one or both ears is a potent cause of faulty speech. It is impossible to repeat correctly what one does not hear distinctly.

White emphasizes the fact that all changes occurring in children's voices are not to be classified as part of the physiologic changes occurring either before or during puberty. The lasting ill effects, not only laryngeal but psychic, may be caused by failure to investigate thoroughly the larynx of a person suffering from disagreeable changes of the voice. Much can be done to improve the speaking voice if there is cooperation between the laryngologist and the speech teacher.

M. V. Miller, Philadelphia.

Nose

Preoperative and Postoperative Medical Therapeutics in Rhinoplasty. M. S. Ersner and M. Alexander, Eye, Ear, Nose & Throat Monthly **26**:23 (Jan.) 1947.

In a series of 200 cases of rhinoplasty, vitamin K and vitamin C were used routinely. Thereby the incidence of primary bleeding was reduced, and late secondary hemorrhage was not encountered. The incidence of ecchymosis and conjunctival hemorrhage was greatly minimized, and wound healing was aided.

When hypothyroidism has been established or is suspected to be present, the administration of thyroid extract serves the purpose of aiding in the reduction of sodium chloride metabolism, thus hastening elimination of water, and so helps to reduce tissue edema.

Sulfadiazine was given routinely, and no case of slough or infection was encountered.

There were no toxic or deleterious effects of these drugs in any of these cases.

Jennes, Waterbury, Conn.

On the Relationship Between Radiological Appearances and Proof-Puncture Findings in Suspected Cases of Infection of the Maxillary Antrum. J. Chalmers Ballantyne, J. Laryng. & Otol. **61**:306 (June) 1946.

Ballantyne, in attempting to assess the value of roentgenograms in the diagnosis of maxillary sinus disease, presents in tabular form the results recorded in 75 consecutive and unselected cases. The films of one roentgenographer and the reports of one roentgenologist were used.

In 9 cases the roentgenograms showed no abnormality, but puncture and lavage were performed on the basis of the clinical history and the findings; no gross

pathologic evidence of disease was discovered. In 58 (80 per cent) of the remaining 66 cases, in which the roentgenograms showed pathologic involvement, puncture and lavage produced evidence of sinusitis. In 48 (83 per cent) of these lavage gave a grossly purulent return, while in 10 (17 per cent) the return showed a "few flakes only."

In 8 cases of the entire series the roentgenograms were positive but the washings were clear. In 1 of these cases cystic fluid was withdrawn from the antrum, and in 2 of the same group and 2 others antral polyps were reported by the roentgenologist. In the remaining 5 cases of the group a thickened antral mucous membrane was reported by the roentgenologist.

Cytologic examination of antral washings and studies with a contrast medium are not mentioned by the author.

LeJeune and Steele, New Orleans.

Pneumatocele Due to Frontal Trauma. P. W. Longo, A. M. Pimenta and F. P. de Aquino, Arq. de neuro-psiquiat. **3**:52 (March) 1945.

A man aged 47 was kicked in the right frontal region by a horse, after which he was unconscious for an hour and bled from the nose a few hours later. The next day he was dull and had no appetite. He remained in this state for eight or ten days, when he suddenly complained of severe headache. At the same time a watery fluid discharged from the nose. About twenty-five days after the accident he became confused and remained so for four days. One month after the injury examination of the nose showed an intermittent flow of clear and bloody fluid and probable diminution of smell; neurologic examination revealed nothing abnormal. The mental examination showed disorientation, recent memory defect, impairment of sleep rhythm and irritability. Roentgenograms of the skull showed a pneumatocele of the right frontoparietal region, with no air in the ventricle; there was no fluid level. Air was definitely present in the intracranial cavity. There was a comminuted fracture of the posterior wall of the right frontal sinus, the roof of the orbit and the right ethmoid bone. There was also a fracture of the nose. Suboccipital puncture showed clear fluid and about 24 cells per cubic millimeter, of which 68 per cent were lymphocytes; the chlorides measured 720 mg. and the albumin 20 mg. per hundred cubic centimeters; the Wassermann reaction was negative. The destroyed bone was removed from the region of the right frontal sinus. Five cubic centimeters of air was aspirated at the site of a very small defect in the dura. Thirty-six days after the operation, no air was seen in the intracranial cavity, and there was striking subjective improvement.

Savitsky, New York. [Arch. Neurol. & Psychiat.]

Staphylococcus Aureus in the Healthy Nasal Cavity. I. J. le Cosquino de Bussy, J. J. van Loghem and A. K. Visser, Nederl. tijdschr. v. geneesk, **86**:1273 (May 23) 1942.

The authors examined 1,559 children and adults to determine to what extent Staphylococcus aureus was present in healthy nasal cavities and obtained in the various groups 36 to 63 per cent positive results. The strains of Staph. aureus which they could cultivate were indistinguishable bacteriologically (examination for pigment, hemolysins, coagulase, toxin and antigenic structure) from strains of this organism isolated from pathologic products. As an epidemiologic contribution, the authors record their experience with a healthy midwife who carried Staph. aureus in her nose and who in the course of one year first infected many

infants, with development of impetigo bullosa, within a short time, and later, after she had been made aware of the danger, caused fresh infections but at long intervals. VAN CREVELD, Amsterdam, Netherlands. [AM. J. DIS. CHILD.]

Miscellaneous

ELONGATION OF THE NASAL COLUMELLA: A NEW OPERATIVE TECHNIC. C. L. STRAITH, Plastic & Reconstr. Surg. **1**:79 (July) 1946.

Straith introduces his original technic for lengthening the columella by mentioning the various methods of correction already in use and by describing the different anatomic varieties of real or apparent columellar shortening. For bilateral cleft lip or for congenital nasal tip with a web of tissue in the anterior angle of the nares, giving the appearance of an abnormally short columella, correction is made by the use of a Z plastic incision on the margins of the alae and on the nasal tip at the angles of the nares. This procedure increases their vertical diameter, and the columella appears longer in consequence. For single cleft lip, with which the short columella is commonly seen, a small skin flap is raised at the upper, inner angle of the nostril, and the underlying alar cartilage is excised, leaving only the lining membrane, which is incised in turn, to form a second flap. Both flaps are then rotated and sutured in a manner which gives the columella greater length. The same operation is done on both sides in double cleft lip. The author comments that this method, like many others, is suitable only in selected cases.

SELTZER, Philadelphia.

UNILATERAL FACIAL PARALYSIS: CORRECTION WITH TANTALUM WIRE. J. E. SHEEHAN, Lancet **1**:263 (Feb. 23) 1946.

Sheehan treated unilateral facial paralysis with tantalum ribbon and wire in 8 cases. The thicker ribbon was found preferable, as it immobilized the parts better and tended less to give under the stress of facial motion. The author describes the technic as follows: After the usual preparation, the paralyzed side of the face is anesthetized with 1 per cent procaine hydrochloride, and a curved incision 2 inches (5 cm.) long is made over the temporal muscle above the zygoma and behind the hair line. The temporal fascia is exposed. A long, curved 18 gage Weck needle is inserted into the lower part of the incision and passed downward between the skin and the mucosa to 8 mm. beyond the midline of the chin, where it emerges. During its course the needle intermittently takes deep bites of tissue. One end of a loop of tantalum wire (or ribbon) is passed through the bore of the needle, which is then withdrawn, carrying the strand of wire back with it to the incision in the temporal area. A second needle is inserted 1 cm. above the first one and follows a course 1 cm. above and parallel to the latter's. The other end of the loop of tantalum wire is passed through the bore of this needle and is carried back. A vertical incision is made on the chin to connect the upper and lower wires, and the skin on each side is undermined slightly. Tantalum foil is rolled around the loop to prevent the wire from breaking through the tissues, and the incision is closed with ophthalmic gut.

The same procedure is carried out at the angle of the mouth and on the upper lip. In the first instance the loop is affixed 0.5 cm. from the corner of the mouth. In the second the lower needle follows the course of the vermilion border to 6 mm. past the midline; the upper needle runs just beneath the base of the nose, so that the pull of the wire helps to straighten the nose.

The three sets of wire (or ribbon) in the temporal incision are then pulled to overcorrect the face slightly and are held in position with clamps. The ends of each set are twisted together; any excess is cut off, and the ends are deeply embedded in the temporal muscle and fascia.

To support the upper eyelid, a needle of shorter design is inserted at the upper portion of the temporal incision and passed under the upper orbital rim, downward and forward, to emerge over the attachment of the internal lateral ligament. A second needle, inserted 1 cm. below the first, takes a course following the lower lid and emerges beneath the attachment of the internal lateral ligament. One end of the wire or ribbon loop is inserted in the lower needle, and a vertical incision, exposing the internal lateral ligament, is made to join the upper and lower wires. The other end of the loop is then inserted in the upper needle, and both needles are withdrawn, leaving the loop moored in the internal lateral ligament. From this point the procedure is the same as for correction of the mouth. When the set of wires supporting the eyelid is securely embedded in the temporal muscle and fascia, the temporal incision is sutured, and sterile bandages are applied. The period of hospitalization is brief, twenty-four to seventy-two hours in all. The author concludes that this method is superior to those discredited methods of repair which joins nerves of different numbers, producing a slight twitching of the facial muscles at best. In contrast to them, traction with tantalum ribbon or wire appears both to support and balance the face and to overcome the antagonistic pull of the muscles on the unparalyzed side. It seems useful either as a permanent support or as a temporary one, during the regeneration of a nerve, in which case the wires can be removed after recovery.

YASKIN, Camden, N. J. [ARCH. NEUROL. & PSYCHIAT.]

TUMOURS OF THE CAROTID BODY. C. A. HAMBERGER, Acta oto-laryng. **34**:104, 1946.

Tumors of the carotid body are uncommon; their diagnosis, very difficult, and many of the pathologic-anatomic problems connected with them, unsolved. The removal of a carotid body is a very delicate operation, and the postoperative mortality is high. Among the postoperative complications are hemiplegia and other neurologic derangements.

The human carotid body is a small oval formation, about 5 by 3 by 1.5 mm., situated on the median side of the common carotid artery and not, as so often described, in the bifurcation between the external and internal carotid arteries.

All histologists call attention to the great abundance of vessels and nerves in the carotid body. The intercarotid plexus of nerves is derived from the superior laryngeal, the vagus, the glossopharyngeal and the superior sympathetic ganglion. What the function of the carotid body is has not been decided. It probably does not belong to the endocrine system. In 1937 Sonck was able to collect only 236 cases of carotid body tumor in a review of the entire literature. Tumors of this type are more common in women than in men, and the usual age of their appearance is around 35. They are usually unilateral, although a few bilateral growths have been described.

The histologic description has caused considerable trouble because the origin of the normal carotid body is not known. White made extensive investigations in 1935 which indicate that the carotid body communicates with the parasympathetic system and is in close connection with the ganglion nodosum of the vagus nerve, because the same kind of cell groups are found in both regions.

Some of the tumors are benign and are regarded as hypertrophy of the body, but others are malignant (Peterson and Meeker, 44.4 per cent; Bevan and McCarthy, 17.8 per cent; Rankin and Wellbrock, 50 per cent).

Hamberger reports 3 cases of carotid body tumor. The patients were aged 28, 36 and 47. In none of these cases was the diagnosis made preoperatively, and the presenting symptom in all 3 was a swelling of the neck. The malignancy of one tumor was established; that of the others is in question. In his first case the tumor tissue was encountered in the outer layer of the adventitia of the carotid artery, and he makes the observation that these tumors can affect the carotid artery either by infiltration or by pressure.

Treatment.—All 3 patients received radiologic and surgical treatment. It is unanimously agreed in the literature that the only treatment to be considered is surgical extirpation. Small tumors offer no particular trouble; operative complications occur only after the removal of large tumors. The reason given for the high postoperative mortality is that blood vessels and nerves are injured during the extirpation of the large tumors. The complications and the mortality are apt to be higher in those cases in which the carotid artery must be ligated, unless previous pressure on, or infiltration of, the vessel resulted in thrombosis.

The carotid body is surrounded by a plexus of fine nerve threads, the plexus caroticus. Irritation of this plexus results in slowing and even stoppage of the heart. To avoid irritation of this plexus it is suggested that even in cases in which the patient is under general anesthesia when operated on a local anesthetic agent should be injected into the region of the bifurcation of the common carotid artery.

GROVE, Milwaukee.

Book Reviews

Histopathology of the Ear, Nose and Throat. By Andrew A. Eggston, B.S., M.D., director of laboratories, Manhattan Eye, Ear and Throat Hospital, and clinical professor of pathology, New York University Medical College, and Dorothy Wolff, A.B., M.A., Ph.D., research investigator, Endaural Hospital, New York, and fellow in research, Harvard Medical School. Price $18. Pp. 1080, with 28 plates in color and 505 figures. Baltimore: Williams & Wilkins Company, 1947.

This is a monumental work, the first of its kind devoted exclusively to the histopathology of the ear, nose and throat. Those who are only casually acquainted with otolaryngology as a specialty may realize that tonsillitis and adenoiditis, sinusitis and otitis are of importance, but they do not always know how diseases which begin in the ears, the tonsils and the sinuses may finally endanger life itself. Complications in any one of them, especially those involving the internal ear, may lead to death through meningitis, general sepsis, acute or chronic cardiac conditions, nephritis—in fact, there is no organ or tissue of the body which may not be reached by bacterial infection which had its origin in the upper respiratory tract or the ears. This is, of course, no news to otorhinolaryngologists, but it needs to be emphasized still, in spite of the many years that have passed since the age of Politzer.

The authors of this volume have brought together all the data which have been published in various scattered journals throughout the world, and have contributed from their own vast store of information, thus leavening the loaf, so to speak, and making the work comprehensive in every detail. It is, in fact, exhaustive; nothing seems to have been omitted, although the preface recognizes that there may be errors of both kinds. It is good to find so much space devoted to the pathology of the nasopharynx and the eustachian tube. Conductive and obstructive deafness, possibly some types of nerve degeneration, also, may follow the infections that result when bacteria invade through the lymphoid tissue which is always present in these areas. The nasopharyngoscope first called attention clinically to this fact, but until now physicians have had too little accurate information concerning the function and the pathologic conditions of the nasopharynx, at least from the microscopic standpoint. Here, comparative anatomy has served, along with other basic sciences, to illuminate and explain such matters as the endolymphatic system, and the relation of "gill slits" to certain anomalous conditions of the neck.

The histology of the internal ear has been well established by European workers —Neumann, Alexander, Siebenmann, Ruttin, Bárány and many others working in various medical centers—but it would seem that the thorough study of the petrous pyramid has been largely the work of American students. Chapter X, although brief, presents cross sections taken from fetal, infantile and adult specimens of this bone, in which the relation to the labyrinth is well and graphically illustrated.

Chapter V explains the method used in procuring autopsy material from the midskull. This is important, because investigators have never had definite guideposts in securing gross sections which may be prepared and cut with the microtome and subsequently photographed under a high power microscope. The German writers excelled in this even before World War I, but there was a lag in this

country, which is now fully compensated in the present work. However, Shambaugh, of Chicago, as early as 1910 paved the way for minute study of the membranous labyrinth, but he seems to have had few followers until fairly recently.

Chapter XIV is devoted to a study of the auditory nerve and its branches, vestibular and cochlear, and chapter XV considers completely the ganglions and nerves of the petrosal region other than the auditory.

The immense detail of this splendid work prevents a reviewer from doing more than touch a highlight here and there. One may well predict, however, that the book will have a permanent place as a "classic" and standard volume for many years to come.

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President: Dr. Lyman G. Richards, 15 Whiting Rd., Wellesley Hills, Mass.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: Chalfonte-Haddon Hall, Atlantic City. Time: April 7-9, 1948.

SECTIONS:

Eastern.—Chairman: Dr. J. Winston Fowlkes, 12 E. 63d St., New York 21.
Place: New York. Time: Jan. 16, 1948.
Southern—.Chairman: Dr. William A. Wagner, American Bank Bldg., New Orleans.
Place: New Orleans. Time: Jan. 23, 1948.
Middle.—Chairman: Dr. Hugh G. Beatty, 150 E. Broad St., Columbus, Ohio.
Place: Columbus, Ohio. Time: Jan. 19, 1948.
Western.—Chairman: Dr. Meade Mohun, 23–2d Ave., San Mateo, Calif.
Place: San Francisco. Time: Jan. 31-Feb. 1, 1948.

American Otological Society

President: Dr. Bernard J. McMahon, 634 N. Grand Blvd., St. Louis.
Secretary: Dr. Gordon D. Hoople, 713 E. Genesee St., Syracuse, N. Y.
Place: Old Homestead, Va. Time: April 12-13, 1948.

American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Alfred Schattner, 115 E. 61st St., New York.
Secretary: Dr. Norman N. Smith, 291 Whitney Ave., New Haven, Conn.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

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